THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 31. Thursday, February 26, 1925. No. 445.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
Soda Ash and Sulphur in Cast Iron	173
Desulphurising Cast Iron with Soda Ash	174
Institute of British Foundrymen	175, 186
The Paris Foundry High School	176
Foundry Trades Equipment and Supplies Association	176
A New Aluminium Alloy-Alpax	177
The Future Improvement of Cast Iron	181
Catalogues Received	184
The Draughtsmen and Foundrywork	185
Discussion on Mr. Faulkner's Paper on "Some Notes on Refractory Materials"	187
The Conveyance of Material in the Foundry	188
Concrete Hardening	189
A New Type of Crucible Melting Plant	190
Tata Iron and Steel Company	190
Trade Talk	192
Company News	192
Contracts Open	192
Iron and Steel Markets	194

Forthcoming Events.

FEBRUARY 27.

Institution of Mechanical Engineers:—Informal meeting in London. Discussion on "Practical Problems of Lubrication."

North-East Coast Institution of Engineers and Shipbuilders:—General meeting at Newcastle-on-Tyne. "Ultimate Possibilities of Steam Plant." Paper by Professor A. L. Mellanby, D.Sc., and Dr. Wm. Kerr, Ph.D.

Junior Institution of Engineers:—Lecturette in London, "A Treatise on Modern Lighting Practice." Paper by E. Stroud.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch):—General meeting at Middlesbrough. "The Problem of the Workshop." Paper by G. M. Harroway.

FEBRUARY 28.

Swansea Technical College Metallurgical Society:—Ordinary meeting at Swansea. "The Foundry Cupola." Paper by F. Halberry.

MARCH 2.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "Oil Sand Cores." Paper by G. Edginton.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.
PRESIDENT, 1924-25, R. O. Patterson, Blaydon-on-Tyne.
LIST OF SECRETARIES—
General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield: R. Village, Albion Foundry, Whittington Moor, near Chesterfield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: Colin Gresty, 93, Queen's Road, Monkseaton, Northumberland.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
West Riding of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.

Welsh Engineers' and Founders' Association.
Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Soda Ash and Sulphur in Cast Iron.

This question was once summarised in a Branch Presidential address to the London Branch of the Institute of British Foundrymen in the following terms:—"For the ordinary foundryman sulphur is a distinct and definite menace; to the technically skilled foundryman a nuisance, because of its local disturbances, but to the foundryman who has specially studied the question it can be high—yet controlled—and a good servant." Such a material as it referred to in the last phrase must be considered as a special alloy. If the above can be taken for granted, and the question is studied in the light of the fact that the sulphur content of scrap is constantly increasing every time it is remelted, it becomes obvious that to neglect means to keep this element within bounds is a metallurgical crime.

A method originated in Germany has been tried out in America by the Griffin Wheel Company, and their results are published elsewhere in this issue. They show that (1) a good sulphur reduction is obtained by using either Dr. Walter's compound or simply sodium carbonate; (2) that it is preferable to fuse the sodium carbonate; (3) that there is a conservation of manganese; (4) that there is no improvement in tensile tests; and (5) that quite a small quantity is preferable to the amount recommended by Dr. Walter.

We are aware that a large foundry in the North Midlands has been practising this type of work for many months when making ingot moulds. The steel makers usually give a double specification when purchasing ingots, by fixing a sulphur and phosphorus maximum limit at either 0.05 or 0.06 per cent., and additionally insist on hematite. Now it so happens that hematite can be relied upon to "fill the bill" so far as phosphorus is concerned, but the sulphur content is so near that after contact with the coke it may not meet the specification. The British firm have not seen their way clear to publish their results; indeed, considering the tests required from ingot moulds, possibly no tests other than chemical ones have been taken.

The two main aspects of sulphur reduction are: (*a*) its reduction in the national scrap pile, and (*b*) the conservation of manganese. It may be thought that the augmentation of sulphur could become so pronounced that it would exceed, say, the total carbon percentage. This is an impression one could easily receive from the perusal of some American literature. We believe that an average commercial saturation-point has been or soon will be reached. Strength is given to this supposition by trials to incorporate sulphur with cast iron—a quite difficult proposition. Manganese, whether added as high manganese pig-iron or as ferro-manganese, is worth conservation, as it costs money either directly or indirectly.

It has been stated that a basic lined ladle is necessary for carrying out experiments with soda ash, but we fail to appreciate this. We suggest that firebrick and fireclay, however, should be used in preference to silica and ganister, as being neutral rather than acid in character. The black-leading of ladles for this purpose would appear to be advantageous. We note the Griffin Company use both tea-pot and bottom pouring ladles for their desulphurised metal—a method worth copying where teeming speeds and costs will warrant.

Any firm who has been successful with the soda ash process would be well advised to broadcast their results and methods used, in order that the practice can become more general and so improve the average composition of the national scrap heap.

Desulphurising Cast Iron with Soda Ash.

In a recent issue of "The Iron Age" an anonymous writer, in an article bearing the title "Soda Ash as Desulphuriser in Foundry," states that for over a year the use of soda ash as a desulphuriser has been standard practice in all of the foundries of the Griffin Wheel Company. Formerly the only method of materially lowering sulphur content in the mixture was to use more pig-iron and to reduce the proportion of old wheels and scrap. Through the use of sodium carbonate as a desulphuriser, it is now possible to procure raw materials without reference to sulphur content, thus allowing wider latitude in the purchase of pig-iron, scrap and returned wheels. In fact, the company is now entirely free to use such proportions of the three classes of material as commercial conditions dictate.

Necessity for a successful method of desulphurising the cupola mixture was brought to a focus by recommendations of the wheel committee of the American Railway Association, calling for a progressive reduction in the sulphur content in wheels during the years 1923 to 1928. These recommendations fixed the minimum allowable sulphur content in wheels as follows:—

1923-1924	0.17 per cent.
1925-1926	0.16 per cent.
1927-1928	0.15 per cent.
1929 and after	0.14 per cent.

Although car wheel manufacturers by no means believed it demonstrated that further sharp reductions in sulphur content would necessarily influence the serviceability of wheels, they accepted the specifications proposed by the railroad body. It is not surprising, therefore, that makers of car wheels gave much thought to ways and means of meeting the new requirements. The innovation in cupola practice at the Griffin Wheel Company plants followed experiments conducted by Frederick K. Vial, chief engineer, after a trip abroad, where he met Richard Walter, head of the Walter Metallurgical Company, Dusseldorf, Germany, who had developed a compound for desulphurising cast iron whilst in the molten state.

Experiments with Imported Reagent.

Mr. Vial arranged for the shipment of a metric ton of the Walter compound, which was received in Chicago in December, 1922. The material was in the form of 1 lb. briquettes. The first test with this material was made in a small hand ladle containing 25 lb. of iron. The chemical action caused boiling and required from 5 to 10 min. for the reaction to become complete. The small quantity of iron by that time was cooled to such an extent as not to be representative of the character of iron that might be produced on a larger scale. It was found, however, that upward of 40 per cent. of the sulphur was readily removable.

Next the treatment was tried in a wheel ladle, which was more successful, although the time required for the reaction to take place precluded its regular use in wheel ladles. It was necessary to hold each ladle 10 min. to get the best results. The next move was to try using the material in a large reservoir or bull ladle. Several tests of this kind were used, extending in some instances over a full day's work. In all some 2,000 wheels were treated, with very good results. Table I indicates the amount of treatment, the sulphur in the untreated iron and also the amount of sulphur actually removed. A test bar was taken from every third tap, each tap representing 12 wheels.

TABLE I.—*Addition of Walter Compound to Bull Ladle.*

A—1 lb. per Wheel or 0.125 Per Cent. Addition to High-Sulphur Mixture.

Bar No.	1	2	3	4	5	6	7*	8	9
Sulphur	0.198	0.174	0.131	0.127	0.134	0.161	0.141	0.151	0.154
Silicon	0.68	0.68	—	0.62	0.64	—	0.64	—	0.65
Manganese	0.62	0.73	0.56	0.55	0.64	0.71	0.73	0.83	0.78
Comb. carbon	0.84	0.78	—	0.107	—	0.96	0.82	0.77	0.84
Chill on test piece	1.50	1.45	1.45	1.50	1.45	1.60	1.50	1.50	1.55

A—1 Low-Sulphur Mixture.

Bar No.	1	2	3	4	5	6	7	8	9
Sulphur	0.146	0.132	0.131	0.120	0.119	0.099	0.103	0.101	0.108
Silicon	0.65	0.64	0.59	0.58	0.54	0.60	0.57	0.61	0.57
Manganese	0.65	0.65	0.70	0.67	0.66	0.70	0.69	0.70	0.67
Comb. carbon	0.69	0.69	0.71	0.68	0.69	0.66	0.65	0.63	0.66
Chill on test piece	1.40	1.65	1.55	1.60	1.55	1.50	1.35	1.40	1.35

B—2 lb. per Wheel—0.25 Per Cent. Addition.

Bar No.	1	2	3	4	5	6	7	8*	9
Sulphur	0.173	0.145	0.124	0.119	0.121	0.126	0.137	0.122	0.149
Silicon	0.66	0.66	0.65	0.63	0.63	0.62	0.63	0.63	0.63
Manganese	0.61	0.65	0.68	0.67	0.66	0.60	0.62	0.60	0.61
Comb. carbon	0.80	0.73	0.76	0.75	0.76	0.74	0.78	0.74	0.77
Chill on test piece	1.45	1.40	1.50	1.55	1.45	1.45	1.20	1.30	1.35

C—4 lb. per Wheel—0.50 Per Cent. Addition.

Bar No.	1	2	3	4	5	6†	7	8	9
Sulphur	—	—	—	0.186	—	0.152	0.127	0.111	0.110
Silicon	—	—	—	0.64	—	0.63	0.53	0.50	0.51
Manganese	—	—	—	0.70	—	0.62	0.70	0.66	0.70
Comb. carbon	—	—	—	0.75	—	0.84	1.04	1.18	1.12
Chill on test piece	—	—	—	1.60	—	1.60	1.65	1.80	1.80

* Treatment discontinued. † Treatment started on Bar No. 6.

Inspection of the table indicates that it is possible, with the correct application of the material, to remove one-third of the sulphur content from melted iron. The material was treated, each time the cupola was tapped, as near as possible to the amount specified in the table. The reaction of the material on the slag was very satisfactory. It has a low melting point and therefore remains very fluid. In the tests, the slag was not removed from the large ladle. It was held all day, which probably accounts for the fact that, at the latter end of the heat, there was less sulphur removed from the iron than during the middle portion of the heat. This apparently was on account of the heavily charged sulphur slag that floated on the iron.

The large ladle was of the teapot type and the small ladles were bottom pouring. The foundrymen seemed to notice that there was less slag in the small ladle than when the large ladle was treated with this material.

Treatment Beneficial, but Does Not Aid Strength.

Aside from removing sulphur, the effect of the treatment is beneficial, for its acts as a cleanser and probably removes oxides, occluded slag, etc., giving a clear appearance to the fracture.

There is no evidence to indicate that the physical properties of cast iron are improved by lowering

the sulphur content. It also is reported from the testing laboratories of Germany that they did not find any improvement in tensile strength accompanying the removal of sulphur. This is in accord with tests made in the Griffin laboratory. In connection with the experiments concerning desulphurising of iron by the Walter method, two comparative tests were made, with the results shown in Table II.

This table indicates that the metal treated with the smallest amount of desulphurising material gave the largest increase in tensile strength, while the effect on sulphur was small. In the case of the heavier treatment there was no perceptible difference in the strength of the bars. Much further research into the strength of irons under various conditions will be necessary before any definite claim can be made for improvement in the iron.

Approximately 90 per cent. of the compound was found to be sodium carbonate, and, from experiments conducted by Mr. Vial, it was found that a radical variation from the German formula produces just about as satisfactory results. In fact, sodium carbonate alone, when properly prepared, will produce the necessary reaction. At first it was attempted to use soda ash as found in commerce, without fusing beforehand, but the material was as fine as flour and flew about the foundries to

TABLE II.—*Comparison of Ultimate Tensile Strength of Untreated and Treated Iron. Using* 0.125 *and* 0.25 *per cent. Additions of Walter Compounds.*

	Untreated.	Treated with 0.125 per cent.	Untreated.	Treated with 0.25 per cent.
	Per cent.	Per cent.	Per cent.	Per cent.
Sulphur	0.160	0.154	0.173	0.144
Silicon	0.64	0.69	0.63	0.61
Manganese ..	0.64	0.67	0.62	0.65
Total carbon ..	3.47	3.33	3.46	3.46
Combined carbon	0.80	0.80	0.80	0.80
Phosphorus ..	0.329	0.337	0.294	0.290
Ultimate tensile strength tons per sq. in. :—				
Bar 1 ..	14.2	15.6	15.8	16.4
Bar 2 ..	14.6	15.2	16.6	15.5
Bar 3 ..	13.2	15.5	—	15.6
Average ..	14.0	15.4	16.2	15.9

such an extent as to become objectionable. A more satisfactory method is to mix the materials, melt them and pour into small moulds of 1 or 2 lb. each.

Reaction and Saving of Manganese.

In adopting the use of soda ash in its regular practice, the Griffin Wheel Company adds the material in the spout rather than in the ladle. This is to facilitate the use of this method in connection with continuous tapping from the cupola. Part of the reaction continues to take place in the ladle, which is periodically tipped backward for skimming. Although the soda ash is fluid and stays on top of the bath, the amount of sulphur throughout the ladle is uniform, as evidenced by samples taken from bottom pouring ladles. This is apparently accounted for by the continuous circulation of the molten metal, due to the cooling of the portion of the mixture which is at the top and in contact with the atmosphere.

Dr. Walter recommended the use of 100 lb. of his compound per ton of iron, but the Griffin Wheel Company has found that the use of 20 lb. per ton of metal is more satisfactory. Incidentally, the use of soda ash is not without its compensations. In ordinary practice, considerable manganese is lost through sulphur in the mixture combining with manganese to form manganese sulphide, which passes off in the slag. Now that soda ash is used, the manganese formerly lost is conserved and the saving is more than enough to pay for the cost of the sodium carbonate.

A LECTURE on "The Properties of Metals at High Temperatures," was given before the Birmingham University Metallurgical Society last week, by Mr. H. D. Ingall, principal of the County Technical College, Wednesbury.

Institute of British Foundrymen.

LANCASHIRE BRANCH (Junior Section).

Mr. R. W. Stubbs presided over a largely attended meeting of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen, which was held at the College of Technology, Manchester, on Saturday, February 14.

Mr. W. H. Meadowcroft, of Tyldesley, a past President of the Lancashire Branch, delivered a lecture on "Some Foundry Experiences," which consisted of descriptions of the operations involved in the moulding and casting of several castings of various types. After some general remarks applicable to moulding of all classes of work, Mr. Meadowcroft described in detail the moulding of a 30 ft. long machine. He dealt with all the operations involved in preparing the mould, and particularly stressed such matters as venting, running and camber.

Mr. Meadowcroft next dealt with a large T-shaped pipe on similar lines. The whole of the examples that he chose were profusely illustrated with diagrams which he had prepared.

At the conclusion of the lecture an animated discussion took place, in which the President of the Lancashire Branch, Mr. R. A. Miles, Mr. Masters Vice-President, and a number of the Junior Section took part.

Presentation to Mr. Makemson.

The first annual social in connection with the Junior Section of the Lancashire Branch of the I.B.F. took place on February 21 at the Milton Hall, Manchester. Mr. R. W. Stubbs presided over the proceedings, and there were present 131, including many leading members of the Branch. After tea an excellent programme of music, etc., was carried out, the artistes including two members of the Section, Messrs. Linaker and Ward. The opportunity was taken to make a presentation to Mr. T. Makemson, the Branch Secretary, subscribed by the members of the Branch, in recognition of his services in connection with the formation of the Section. It took the form of a gold fountain-pen.

MR. R. A. MILES, the Branch-President, said there was need for ability and foresight amongst the Junior Section, because the management of the affairs of the Senior Section would at some time fall into the hands of those he was addressing. They had excellent examples to follow. In particular they would have reason to regard Mr. Makemson as one of their greatest benefactors, because he was largely responsible for the establishment of the Junior Section.

MR. O. STUBBS said it was one of the privileges he had in connection with the Institute to have the honour of making the presentation on this occasion. If the members of the Junior Section wanted to learn the valuable lesson how to make one's way to the front by hard work and persevering effort they had only to follow in Mr. Makemson's footsteps. Certainly there were some among them who could do it if they had the mind, so it was no use saying they could not. All that was required was that they should do their best. He was glad to see so many present, because it proved that that spirit was not wanting.

MR. MAKEMSON said it was rarely he was at a loss what to say when expected to speak, but that was how he felt on this occasion. For what he had done in the formation of the Section he had already been amply rewarded by seeing it succeed. But that was by no means due to his efforts alone. Other members of the Branch had done most valuable service. They included Mr. O. Stubbs himself, Mr. R. A. Miles, Mr. R. W. Stubbs, Mr. Jolley, Mr. Smith, and Mr. Masters. The Section had been set afloat; it was self-governing, with its own Council, and the control was entirely in the hands of its members. It should prove a most valuable instrument for their own good, and for the benefit of other people in the foundry trade, but whether or not it would fulfil its potentialities in that direction depended entirely upon those in the Section. So he urged them to support it by attendance at meetings, taking part in the discussions, and making its advantages known to others, so that new members might be brought in.

The Paris Foundry High School.

By Our Paris Correspondent.

When in July, 1923, the Syndicat des Fondeurs de France, at a general meeting, created in Paris a Foundry High School, it certainly rendered a great service to the industry. The foundries, as a matter of fact, were previously solely dependent upon men who were only specialised through practice. There was at this time in France, and also abroad, neither University nor school bringing together all that a foundry manager must know, both from the metallurgical and professional standpoints.

Realising this, the Syndicate were guided by two general and fundamental principles:—

(1) The rapid production of managers able to render immediate services; and (2) the careful selection of the students, with the view of reducing to a minimum the chance of having them leave the profession.

These principles led to the special recruitment of the students. They were limited to practical men of some experience and education, foremen, metallurgists, etc., such as the pupils of secondary schools who have worked in a plant for some time. The time of practical training required was initially fixed at two years, but was reduced to one year later on. Now it is six months for secondary school graduates and one year for all other candidates.

These two categories are, therefore, constituted by men whose career is already determined. It is hoped, additionally, that the leading firms will have at least one of their staff attend the classes. The Ecole Supérieure de Fonderie is thus definitely distinguished from other specialised technical schools where students are trained who have but rarely had a previous technical education.

The classification of the students is made by means of an examination covering scientific and practical subjects. Contrary to what had been decided initially, that is, a practical examination for the pupils of secondary school and theoretical examination for the practical men, the examination is now standard for all candidates, because some of them may have lost some of the theoretical notions they had previously acquired, whilst others may have, in spite of their practical training, no real practical knowledge.

The Ecole Supérieure de Fonderie, which is administered by a committee of thirteen members, the head of which is a foundry specialist, assisted by a chief resident teacher, opened its doors in January, 1924. The programme of work was entirely planned by the Syndicate, and the classes consist of two grades of courses:—

(1) Metals and their properties, elements of manufacture, sand, etc.; and (2) actual manufacture, moulding, etc.

Each course is based on the same principle: preparation of the student to a degree of general knowledge followed by some practical teaching of various specialities, by means of lectures delivered by specialists. The connection between the two series of classes is made through a certain number of additional courses, conducted this year by two graduates of the school for the 1924 session.

While the technical lectures are given by consulting engineers and professors of the secondary schools, the practical courses are conducted by specialists, foundry managers, who lecture upon the one particular question they are studying every day. However, either theoretical or technical, the course always tends to develop initiative of the student. In the metallurgical course, for instance, all technical considerations are set up in such a manner that the practical details are easily grafted on, and when a controversy arises on the question discussed the practical result only is communicated to the student.

For the examinations, summaries of these various courses, including figures, are given to the students; meanwhile, they have to note down matter from their own courses which forces them to put in work of an intensive character. The classes are usually followed by informal discussions on the subjects developed.

The practical courses cover the following subjects:—Chemistry, physics, cupola practice, patterns, moulding machines. Additionally, a large part of the practical work is devoted to personal work. In a general way, the student himself makes the moulds he requires for his own use. Amongst other work, the students have to carry out various moulding operations and to write reports of visits to a foundry. For the moulding work the student is given directions which he has to follow, so that his work can be directly entrusted to a foreman and completed from start to finish. On the other hand, the visits to foundries have been instituted not only to train but to accustom the student to observe in a precise and systematic way. Thus, at the beginning of the school year, one common point in foundry work is given to the pupil to study, so that he will not get lost in a multitude of details. And, lastly, the student has, at the end of the year, to write a report on his personal researches on a subject of his own selection. Last year several of these reports were quite interesting. Two of them were presented at the National Congress of Foundry in 1924, one by M. Debar on the classification of defects in castings, and the other by M. Lemoine on the present position of the question of moulding sands.

The close co-operation of the school with the Syndicate's foundries has been achieved as they place their plants and laboratories at the disposition of the school.

After his instruction at the Ecole Supérieure de Fonderie is completed, the student can render immediate services and be given responsible posts. This happened last year, and all the ex-students have given satisfaction to their employers.

The Ecole Supérieure de Fonderie is by no means trying to give a full training in foundry work, but is only completing the education of students possessing already a wide knowledge in this branch. On the other hand, the special recruitment of the students is to bring about an innovation, as the following example shows:—A young man of elementary education may start his apprenticeship in a foundry and learn the trade for several years, complete his theoretical education in the evenings at home, and may, after a certain time, be capable of taking his course at the Ecole de Fonderie, and come out a fully qualified man. Such a fine example will no doubt be followed; already some of the industrial countries are making inquiries about the organisation of the school, and if we may base ourselves on the recent visit of two directors of important British firms, similar institutions will soon be founded abroad.

Foundry Trades Equipment and Supplies Association.

At a meeting, held in St. Bride's Institute, London, E.C., last Thursday, the formal business necessary for the incorporation of the association was carried through. Col. W. F. Cheesewright, D.S.O., was elected the first president, and Mr. A. S. Beech, of the Universal System of Machine Moulding Company, Limited and Mr. H. Winterton, of Messrs. Cummings, Limited, were appointed vice-presidents. It was decided to enter into an agreement with Messrs. F. W. Bridges and Sons, Limited, to support a Foundry Exhibition, to be held at the Agricultural Hall in June, 1926. Mr. K. W. Bridges was elected honorary secretary. His address is Avenue Chambers, Southampton Row, London, W.C.1.

Mr. Frank Russell, F.G.S., F.E.S., Managing Director of the General Refractories Company, Limited, of Sheffield, was the speaker at a meeting of the Sorby Scientific Society, held on February 19. The subject of his address was "China Clay," its occurrence in nature and uses in commerce.

Mr. E. Harland Hutchinson, who has for many years specialised in burning coal in pulverised form, has accepted an important executive position with Vickers & International Combustion Engineering, Limited, of Africa House, Kingsway, W.C.2, owners of the well-known Lopulco patented system of pulverised fuel firing. He will have charge of developments of the firm's interests in the Dominions and Colonies, and is shortly proceeding to Australia via U.S.A. and Canada.

A New Aluminium Alloy—Alpax.

By Leon Guillet, Paris.

Translated by ROBERT J. ANDERSON, Boston, Mass.

(*Abstract.*)

(*Continued from page* 165.)

Physical Properties.

Certain of the physical properties of alpax have been determined by different investigators. Some determinations have been made recently in France with the following results, viz.:—Density, 2.60 to 2.64; coefficient of thermal expansion, 21.6 × 10-^{6}; and specific electrical resistance, 4.6 microhms per cm.^{3} at 20 deg. C. The very complete investigation by Edwards contains many data for the density of several aluminium alloys at various elevated temperatures, but owing to lack of space these cannot be included here. Edwards indicates that the coefficient of thermal expansion between 20 and 577 deg. C. is 23.5 × 10-^{6}, that of aluminium being 29 × 10-^{6}. The density of alpax is considerably less than that of the usual commercial aluminium alloys, and the coefficient of thermal expansion is also lower.

Solid Shrinkage.

The solidification shrinkage of alloys (*i.e.*, the amount of contraction on passing from the liquid state to the solid state) is of great importance in founding. The shrinkage of aluminium is 0.204 in. per ft. (1.7 per cent. = 17 mm. per m.), that of the 92:8 aluminium-copper alloy is 0.150 in. per ft. (1.25 per cent. = 12.5 mm. per m.), while that of alpax is 0.132 in. per ft. (1.1 per cent. = 11 mm. per m.). Thus, the shrinkage of alpax is relatively small, being of the order of cast iron. It is important to bear in mind that the contraction of alpax is small, since the contraction of most of the usual casting alloys is rather high.

Corrosion.

As is well known, the corrosion of aluminium alloys by various media is of much importance in considering different alloys for specific industrial applications. Unfortunately, tests made for corrodibility are not always reliable, and the results are liable to be in error. Figs. 6 and 7 show graphically the loss in weight of alpax, aluminium and some alloys on corrosion in concentrated nitric acid, as determined by Czochralski. It is of interest to note that cast alpax is much more resistant to corrosion in this medium than are the three other materials. However, the loss in weight of rolled alpax is greater than that of rolled aluminium and duralumin.

Investigation in the laboratory of the Metallbank und Metallurgische Gesellschaft has shown that the corrosion of cast products by sulphuric and nitric acid is greater than of rolled products; this is, of course, general and does not apply to alpax alone. In the case of a large number of corroding solutions, alpax approaches aluminium in its resistance to attack, and accordingly this alloy is generally superior to other commercial aluminium alloys from the point of view of corrodibility. However, alpax (and aluminium also) is more easily attacked by alkaline solutions than certain other alloys, *e.g.*, aluminium-copper alloys. At the same time the resistance of alpax to corrosion by sea water is particularly high, and this alloy presents a real superiority over other aluminium alloys in applications where sea mist and water are encountered.

Rolled and Drawn Alpax.

Alpax is especially suitable for the production of castings, and it does not have exceptional properties when rolled or otherwise worked. Some tests have been made in order to obtain further information on the mechanical properties of the alloy when worked. Two lots of rolled 86.5:13.5 aluminium-silicon alloy were prepared at the works of the Société Métallurgique de la Bonneville. One lot was refined (being consequently alpax) and the other was unrefined. Ingots were cast 100 mm. dia. and broken down at 425 to 450 deg. C. to bars 20 mm. dia. The rolling operation did not present any difficulty.

A series of mechanical tests were made on samples of the two lots, as rolled and after annealing, and the materials were examined macroscopically and microscopically. Table VII gives some of the mechanical-test data obtained. As will be seen, the results are distinctly inferior to those obtained in cast alpax. It will be noted also that the refined alloy has better properties than the unrefined. Annealing, for the time and at the temperature employed, has the effect of decreasing the tensile strength and elongation, while the impact resistance, although originally small, is slightly increased. It may be concluded, as has been done on the basis of previous tests, that mechanical treatment has a detrimental effect upon certain qualities of alpax.

Macroscopic examination of these two lots of alloys showed plainly the difference in structure between the refined and unrefined products, as is the case with cast alloys. The worked alloys showed rather large amounts of free silicon and of the aluminium-silicon solid solution. Normal cast alpax consists ordinarily of a fine eutectic structure, with, at times, a little free aluminium-silicon solid solution. At the same time, the eutectic portion of the two worked alloys did not present the same aspect; the unrefined alloy had a more coarse eutectic, as contrasted with a very fine eutectic in the refined product. However, in both these alloys there was found not only the aluminium-silicon solid solution, in addition to the eutectic, but also grains of free silicon. Macroscopic examination of the original ingots showed nicely the existence of segregation in the two alloys as cast.

On the basis of the foregoing, then, an entirely different conclusion is arrived at from that held hitherto, viz., while refining has the effect of producing a very fine eutectic structure, there is segregation in cast ingots of sufficiently large size (or what amounts to the same thing, when the rate of cooling is sufficiently slow) so that free silicon and the aluminium-rich solid solution separate out in relatively large masses. Certain properties of the alloy are lowered because of this larger state of division of the constituents, as contrasted with the typically fine eutectic structure of alpax. This conclusion seems to the present writer to be of especial importance. Thus, in a practical way, it will obviously not be possible to

TABLE VII.—*Mechanical Properties of Hot-Worked and Annealed* 86.5:13.5 *Aluminum-Silicon Alloy; Refined and Unrefined.*

Condition of the Samples.	Elastic limit.	Tensile strength.	Elongation.	Reduction in area.	Brinell hardness.	Charpy impact resistance
	Tons per sq. in.	Tons per sq. in.	Per cent.	Per cent.		Kg.-m. per sq. cm.
As received; not refined	5.8	9.6	13.5	20.7	45	0.8
Annealed 1 hr. at 350 degrees Cent.; not refined	4.2	8.8	14.0	23.3	43	1.0
As received; refined	6.3	10.4	10.0	24.6	48	1.0
Annealed for 1 hr. at 350 degrees Cent.; refined	4.3	10.2	7.6	28.3	46	1.3

exceed a certain size in the production of castings for parts or ingots for rolling, drawing, or other working, without accelerating the rate of freezing, since otherwise in castings of too large cross section serious segregation will be produced which will have harmful effects on the properties of the manufactures. Apparently, the size of casting to be made in sand will have to be limited, or else the rate of cooling will have to be accelerated, as

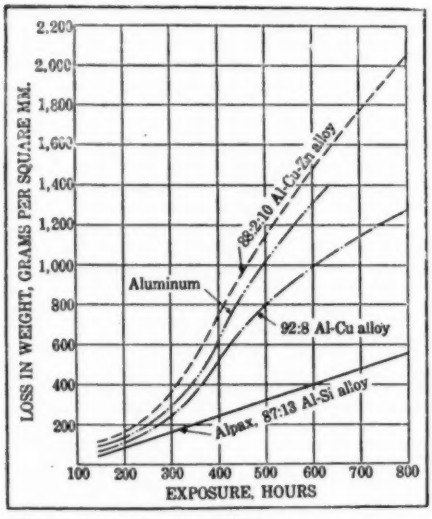


FIG. 6.—LOSS IN WEIGHT IN CONCENTRATED NITRIC ACID OF CAST ALPAX, ALUMINIUM AND TWO ALLOYS (CZOCHRALSKI).

is done, for example, in the production of aluminium bronze. It should be stated that heat treatment has no effect in overcoming the bad effects of segregation, and the effects of segregation in a cast ingot will be seen in the finished product. In the matter of wrought alpax, therefore, it appears that the thermal treatment prior to rolling does not destroy the properties of the alloy, but any deterioration in properties, as compared with cast alpax, should be traced to segregation in the original ingot.

Tests have been made on the effect of rolling and annealing temperatures on the properties of alpax, and it has been found that the best rolling temperature is 475 deg. C. Reduction of 50 per cent. may be made at this temperature. In rolling, the temperature may be ± 50 deg. C. from the temperature just given, for practical operations.

Rolled and annealed alpax has the following tensile properties:—Tensile strength, 10.1 tons per sq. in. (16 kgs. per sq. mm.), and elongation, 28 to 30 per cent. Hard-worked alpax has the following tensile properties:—Tensile strength. 15.9 tons per sq. in. (25 kgs. per sq. mm.), and elongation, 5 per cent.

In order to obtain an alloy having maximum ductility (30 per cent. elongation), it is necessary to anneal at about 350 deg. C. This temperature may be varied ± 50 deg. C.

Coalescence on Prolonged Anneal.

The general question of the mechanical working of alpax has been discussed previously, and it has been indicated that the belief that ordinary heating prior to working and working itself are deleterious to the properties of the alloy, is erroneous. It might be thought that heating prior to working might have a harmful influence, if sufficiently extended, by causing coalescence of the constituents, but for the phenomenon to be very marked it is necessary to anneal for a fairly long time and at high temperature. In practice, it is accordingly advisable not to exceed 450 deg. C. in heating for breaking down ingots, if the heating must be somewhat prolonged. When coalescence is thorough, the hardness of alpax is considerably decreased.

Machining.

Experiments have been carried out recently at the Metallbank und Metallurgische Gesellschaft which have defined the best conditions for machining alpax.

Turning does not present any special difficulty, at least when suitable speed is used. Turning may be done well with a speed of 656 ft. per min., rate of speed of 0.0138 in., and depth of cut of 0.1378 in. Threading is done best with an angle of 70 to 85 deg. and a speed of cut of about 16.4 ft. per min. It is advisable to use a tap with four cutters, with an angle of cut of 60 deg. Threading should be done under lubrication and not dry. Drilling is rather difficult, at least with American drills. The best results have been obtained with ordinary drills, but having an angle of crown of about 80 deg. The feed in drilling should not exceed 0.0142 in., and at a speed of 98 ft. per min. It is advisable to rough-drill holes and then finish with two cuts with a well-sharpened reamer.

Milling is done well at speeds between 197 and 492 ft. per min. and feeds of 0.0118 to 0.0315 in. per turn of miller. The milling cutter should have rectilinear teeth, as those with helical teeth give poor results. Milling should always be done under lubrication. The best lubricants for milling alpax are mixtures of soap and water or oil and water. The oil-water mixtures are best for milling at high speed.

In passing it may be stated that the autogenous welding of alpax has been studied, and it may be pointed out that zones of weakness are set up at welded junctures as in the case of aluminium. Alpax may be coated with metals and also electroplated with copper or nickel, as in the case of aluminium.

TABLE VIII.—*Mechanical Properties of Cast and Rolled Special Aluminium-Silicon Alloys, compared with Aluminium-Copper and Aluminium-Zinc Alloys.*

Composition of alloy, elements per cent.				Elastic limit.	Tensile strength.	Elongation.	Reduction in area.	Brinell hardness.	Charpy impact resistance.
Al*	Si	Cu	Zn	Lbs. per sq. in	Lbs. per sq. in.	Per cent.	Per cent.		Kg.-m per sq. cm.
					Cast alloys.				
87.9	12	1.1	—	22,600	22,600	2	7.3	60	0.3
85	12	3	—	29,900	29,900	(?)	(?)	84	0.2
82	13	5	—	26,900	26,900	1	5.9	73	0.2
93	—	7	—	—	19,100	—	—	85	0.2
97	—	—	3	20,000	30,300	2.2	7.3	70	0.5
95	—	—	5	20,800	32,300	3	7.3	74	0.3
93	—	—	7	22,800	22,800	0.6	4.5	72	0.2
90	—	—	10	—	28,300	0.8	4.5	78	0.2
					Rolled alloys.				
87.9	12	1.1	—	17,100	49,100	9.5	34.3	—	3
85	12	3	—	10,000	34,700	10	20.4	—	1.2
82	13	5	—	19,900	28,400	4	(?)	—	0.6
93	—	7	—	22,900	40,100	6	16.8	—	0.6
97	—	—	3	16,500	27,200	14.5	27.1	—	1.2
95	—	—	5	17,900	29,700	13	23.3	—	1.2
93	—	—	7	21,300	34,000	14	20.7	—	1.2
90	—	—	10	22,500	33,100	4	(?)	—	1.2

* Aluminium by difference.

Special Alpax Alloys.

As has been explained, alpax is the aluminium-silicon alloy containing 13.5 per cent. silicon which is modified by a special refining process, *e.g.*, that of Pacz. It might be asked whether special alloys having the properties of alpax could not be made by substituting for part of the aluminium a binary solid solution, *e.g.*, aluminium-copper or aluminium-zinc solid solutions rich in aluminium. Some special alloys have been made by the writer in which copper and zinc were added to aluminium-silicon alloys, and whilst the results were rather irregular, it was shown that the cast alloys were not any better than ordinary alpax. Most of the rolled special alloys had better properties than ordinary rolled aluminium-silicon alloys, but a good alloy for rolling has the nominal composition 87 : 1 : 12 aluminium-copper-silicon.

Industrial Applications of Alpax.

Alpax is suitable primarily for the production of castings. While it can be cast readily in either sand moulds or chill moulds, a few precautions may be given as to manipulation. On casting in chill moulds, the mould temperature ought to be held rather high, *i.e.*, about 500 deg. C. This is considerably higher than the temperature employed ordinarily for aluminium alloys, viz., 200 deg. C. However, the temperature of the mould should not be too high, since then the alloy would crystallise coarsely and be very brittle. Alpax is cast in dry-sand moulds in the case of thin or irregular castings, but when the coring is complicated, green-sand moulds are employed. When using green-sand moulds, the mould may be skin

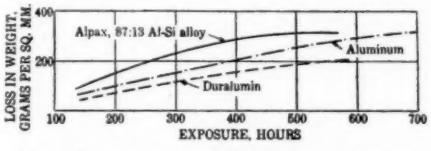


FIG. 7.—LOSS IN WEIGHT IN CONCENTRATED NITRIC ACID OF ROLLED ALPAX, ALUMINIUM AND DURALUMIN (CZOCHRALSKI).

dried on the face by the flame of a welding torch. The sand used for moulds is the same as that ordinarily employed for casting bronze. Graphite may be added to the sand mix in making up cores.

In preparing alpax, the alloy is melted in graphite-clay crucibles, heated to above 900 deg. C., and the refining salts added in the amount of 3 per cent. The salts are stirred in with a graphite rod, and then the resulting dross is skimmed off. The melt is next cooled, and then poured at 600 to 700 deg. C., depending upon the size of the casting. It should be emphasised that the melt should not be allowed to stand at high temperature after the refining operation. Gates, risers, and other scrap may be used in the amount of 40 to 50 per cent. with new metal in making up heats.

Referring to specific applications of alpax, tests made on alpax pistons for internal-combustion engines indicates that the alloy is superior to the ordinary 90 : 10 aluminium-copper alloy, because the thermal expansivity of the former is less. The ordinary clearance used for cast iron is suitable for alpax, and with such clearance no slap occurs. Tests have been made on alpax connecting rods, cylinder blocks (with or without iron liners), and on rear-axle housings, and the results have been quite encouraging. Castings have also been made in the alloy for parts of railway cars, and Fig. 8 shows a door and frame for a railway carriage cast in alpax.

Of course, when cast alpax is substituted for steel in specific applications, it is necessary to increase the dimensions considerably. Thus, it has been pointed out by de Fleury, who has been engaged in the production of alpax parts, that in the case of rear-axles and differential housings for motor cars the sections should be increased in the proportion of 1 : 1.7. However, even with this increase, very marked savings in weight can be effected by the use of alpax in place of steel. According to de Fleury, if alpax be substituted for iron and steel in the cylinder blocks, axle housings, and some minor parts, an ordinary car weighing 770 lbs. will weigh 10 per cent. less.

A set of alpax castings for the rear-axle housing and wheels of a motor bus is shown in Fig. 9. This was cast by the Forges de Crans for the Société des Transports, which operates in the Paris district. These parts have been put into regular service, after satisfactory tests. The gain in weight by using these parts in place of cast steel parts is 562 lbs.

It is apparent that the field of application of alpax is quite wide, without consideration of the applications already made. Some precautions are, of course, necessary in making new applications, and consideration should be given to the necessity for increasing the size of sections when substituting the alloy for iron or steel parts.

DISCUSSION.

By ROBERT J. ANDERSON,* Boston, Mass.

This Paper by Dr. Guillet, which has been translated by the writer, should be of especial interest because of the numerous data presented as to the mechanical properties of aluminium-silicon alloys and also because it reflects late European developments in the use of these alloys for castings. The information presented should be found of interest by foundrymen and metallurgists engaged in the production of aluminium-alloy manufactures.

It should be stated at the outset that the alloys under discussion are not referred to as alpax in the United States, and there is certainly nothing to be gained by fastening trade names and catch terms on alloys. It seems to the writer more logical to talk about aluminium-silicon alloys than to use such terms as alpax, aladar, silumin, etc., as is done abroad in discussing aluminium-silicon alloys.

There are a number of items in the present paper which call for discussion, and these are taken up briefly below.

FIG. 8.—RAILWAY CARRIAGE DOOR CAST IN ALPAX.

In the first place, Dr. Guillet states that the density of duralumin is 2.7 to 2.8. Now, conceivably, the density of some duralumin-type alloys, *e.g.*, aluminium-copper-magnesium-silicon alloys rather low in copper and high in magnesium and silicon, might be as low as 2.7. However, the density of ordinary simple duralumin is certainly not 2.7, but rather 2.8. Dr. Guillet also states that the heat treatment of cast duralumin yields a heterogeneous product. The quenching heat treatment of duralumin does give rise to unstable equilibrium in the alloy, but it would undoubtedly be less heterogeneous than as cast.

It is stated that the range of tensile strength for various light aluminium-casting alloys is some 7.6 to 9.5 tons per sq. in., with elongation of 3 to nil per cent. These figures are obviously incor-

* Consulting Metallurgical Engineer, Boston, Mass.

rect. The range of tensile strength of commercial light aluminium-casting alloys is much wider. Thus, the strength of the 70:30 aluminium-zinc alloy, sand cast, is some 17 tons per sq. in. The elongation given for cast aluminium is too low and the tensile strength is too high, *i.e.*, the figure 6.2 tons.

Referring to the method used for the so-called refining of the 86.5:13.5 aluminium-silicon alloy, it may be pointed out that in the United States the refining process, so-called by Dr. Guillet, is termed modifying the alloys. The ordinary alloys made up by adding silicon to aluminium are termed normal alloys (the unrefined alloys of Guillet), while the alloys when treated with an alkaline fluoride, or otherwise, are termed modified alloys. In passing, it may be of interest to add that the patents taken out by Pacz bearing on the treatment of aluminium-silicon alloys include the following:—English Pat. Nos. 158,827, January 26, 1921; 160,426 and 160,427, March 18, 1921; Canadian Pat. No. 209,696, March 22, 1921; and U.S. Pat. Nos. 1,387,900, August 16, 1921, and 1,464,625, August 14, 1923. In essence, the method of Pacz calls for the modification of the normal aluminium-silicon alloys by treatment in the liquid state with a flux consisting of an alkaline fluoride, preferably sodium fluoride, plus an alkaline chloride or an alkaline-earth fluoride. The flux is placed on top of the liquid alloy and

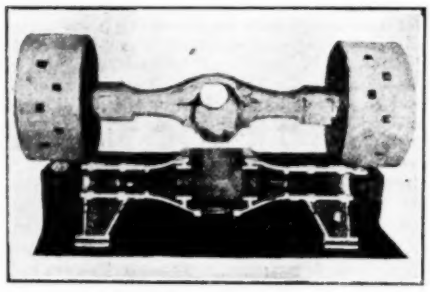


FIG. 9.—OMNIBUS WHEEL AND AXLE HOUSING CAST IN ALPAX.

stirred in. It should also be added that a process for the modification of silicon-bearing aluminium alloys has been patented by the Aluminium Company of America (cf. English Pat. Nos. 171,996 and 171,997, November 15, 1921; and 172,018, November 23, 1921; and U.S. Pat. No. 1,410,461, March 21, 1921). The process calls for treating liquid alloys with 0.05 per cent. of sodium or potassium, or both. Addition of sodium disperses the silicon and thus modifies the alloys.

The work of Vigouroux on the condition of silicon in aluminium is cited. According to Vigouroux, the silicon was regarded as occurring in the free state in aluminium-silicon alloys, and he points out that this is proved by the fact that attack of the alloys by hydrochloride acid yields a residue which contains the silicon. It is now known on the basis of work at the National Physical Laboratory and elsewhere that silicon exists in several forms in aluminium-silicon alloys, viz., (1) as a solid solution in the aluminium; (2) as free silicon forming an eutectic with the aluminium-silicon solid solution; (3) as free silicon in excess in hyper-eutectic alloys; (4) as FeSi, probably; and (5) as (AlFeSi)X—the complex compound of Merica. When aluminium-silicon alloys are dissolved, as in ordinary chemical analysis, it frequently happens that part of the silicon is unattacked and is determined in the residue as free silicon, while part is oxidised and is determined as silica, SiO_2. It has been shown that the silicon which is oxidised to silica is that part which had existed in the state of the aluminium-rich aluminium-silicon solid solution, while that which is determined as free silicon had existed as crystals of free silicon in the alloy, as shown by Rosenhain, Archbutt, and Hanson.*

In the matter of the work of Frilley on the tensile properties of wrought aluminium-silicon alloys, attention might very well be directed to the experiments of Schirmeister, who has rolled alloys containing 0.5 to 18.8 per cent. silicon.

* In the Alloys Research to Inst. of Mech. Engs., 1921.

Regarding the diagram of thermal equilibrium, the writer has taken liberties with Dr. Guillet's Paper and replaced his diagram with another one. It was felt, however, that the diagram used lent itself to discussion better, and the text was accordingly changed with appropriate footnote remarks so as not to alter the opinion of Dr. Guillet regarding the position of the eutectic. The diagram, as given, refers to the normal (*i.e.*, unrefined) alloys, and it would certainly be useful if a diagram would be completely worked out using modified (*i.e.*, refined) alloys. There is considerable difference of opinion as to the precise placement of the eutectic in both the normal and modified alloys. Different investigators have placed the composition in the normal alloys at from 9.5 to 11.6 per cent. silicon, while the composition in the modified alloys has been placed at from 13 to 15 per cent. silicon. The melting point of the eutectic is also given as from 570 to 578 deg. C.

Attention should be directed to the tensile properties of the cast unrefined alloys given in Table II. The results are certainly most curious, and it is difficult to believe, for example, that strength as high as 9.9 tons can be obtained in cast 98.8:1.2 aluminium-silicon alloy.

It is stated in the Paper that cast duralumin does not give noteworthy results when heat treated. Now, it is well known that suitable heat treatment, when applied to cast duralumin-type alloys, does enhance the mechanical properties very materially, and Dr. Guillet's statement apparently should be modified.

Referring to Fig. 6, the strength given for rolled aluminium at 400 deg. C. is evidently too low.

There are some other items which require explanation, but these are apparent, and do not require discussion here.

It may be pointed out that the high-tenor aluminium-silicon alloys, *e.g.*, 87:13 aluminium-silicon, are not being used extensively in the United States. Difficulties with machining have retarded their wider employment. The 95:5 aluminium-silicon alloy is used considerably by the General Electric Company for sand castings, and interesting ternary aluminium-copper-silicon alloys have been developed in the United States recently, and are being used to some extent. In preparing aluminium-silicon alloys, the silicon can be introduced as elemental silicon of high purity, or in the form of intermediate alloys, *e.g.*, 50:50 aluminium-silicon. One of the most valuable properties of the alloys is their relatively low contraction on freezing, and this is explained by the fact that silicon expands on freezing. It has generally been held that the yield point of the aluminium-silicon alloys is rather low, and it is of interest to direct attention to the high values shown by Dr. Guillet for the property.

THE OFFICIAL RECEIVER in the Companies Winding-Up Division of the High Court of Justice has issued his report on the compulsory liquidation of Vulcan Union, Limited, metal and machinery merchants, etc., 1, Charing Cross, S.W., against which a winding-up order was made on April 29. A statement of affairs shows as regards creditors, ranking liabilities £18,066, and assets estimated to produce £50,000, thus showing a surplus, subject to cost of liquidation, £31,934. As regards shareholders, the paid-up capital was £6,740.

A MEETING OF THE creditors of John Spencer & Sons, Limited, in voluntary liquidation, has been held at Newcastle. The liquidator submitted an approximate statement of affairs, which showed that the amount required to pay off the debentures, interest, receivers' costs, etc., would be about £200,000, and that the creditors' claims, including a large amount due to the Income Tax Commissioners, amounted to £34,000. The assets consisting of land, buildings, machinery, plant, etc., standing in the books, showed a total of £523,000, and the loose or liquid assets amounted to £76,000, making a total of £599,000, so that after deducting £200,000 for debentures there remained a balance—subject to realisation—of £399,000 for the creditors. The item of land, buildings, etc., although it stood in the books at £523,000, had cost the company considerably over £1,000,000 from first to last. During the past 30 years or so, £286,250 had been written off as depreciation, and £219,545 had been expended out of profits for renewals, improvements, and extensions of building and plant. The intention was to try to reconstruct the company.

The Future Improvement of Cast Iron.*

By J. G. Pearce, B.Sc. (Director of the British Cast-Iron Research Association).

The considerable progress which has taken place in cast iron is well illustrated by the fact that eighty years ago its average tensile strength was not more than seven tons per square inch. This progress had followed two main directions—a progressive lowering of the cost of production, apart from abnormal periods such as the war and post-war period, and a steady improvement in quality. Progressive industries could only be built up on these lines. A consistent and regular reduction in cost resulted in an increased demand, which provided for a natural expansion of the industry and for the steady growth and promotion of those engaged in it. The steady improvement in quality enabled the material to hold its own with competitive materials, and to meet the increasingly severe standards of performance set by engineers.

The improvement referred to is brought about only in one way—by the introduction into the industry of new knowledge, but this new knowledge entered the industry through different channels. In the first place, those actually engaged in the production of cast iron in various forms could scarcely fail to learn more about the material and methods of production, and this resulted in an increasing body of knowledge and experience which became incorporated into the traditional procedure of the industry. Occasionally, striking improvements, often taking the form of inventions, were made by men outside the industry. Nowadays a third channel of improvement was open, namely, that secured through scientific research. It was now generally accepted that the sciences of chemistry and physics had provided the trade with means of knowing more about the internal structure of metals than was possible by ordinary visual examination, and it was futile to deny or disprove the improvements resulting from the application of the science of metallurgy.

A good deal of argument had taken place from time to time with regard to the respective merits of examination of fracture and chemical analysis. At one time visual examination was the only method open to the intelligent founder, and he naturally made the fullest possible use of it. Later it was anticipated that chemical analysis would provide still more information. At a still later period microscopic examination was employed, and for it also some exaggerated claims were made. To-day it is appreciated that cast iron is so complex, being in fact more complex than any other structural or engineering material in common use, that every possible aid is needed in studying it—the practical knowledge and experience of the founder, the analysis of the chemist, the microscopical examinations of the metallurgist, the mechanical tests of the engineer. Workers in various sections of the industry know that results from the whole of these sources must be incorporated into one whole if the most intelligent examination is to be made. It was unfortunate that a few practical men, who had, perhaps, occasionally been misled in the early days by chemists and metallurgists inadequately trained on the practical side, should have closed their minds to the value of science. It was still more unfortunate that a few half-trained scientists had tried to discount the value of practical experience. It was imperative to realise that the value of science in the foundry must be judged entirely from the economic aspect. It was of no use making a change in practice, however theoretically desirable, unless the results could be justified economically. It was frequently of little use making slight improvements in one direction and leaving glaring sources of waste in another. It was little use scientifically mixing pig-irons and weighing charges if melting practice or moulding practice was unsatisfactory. It was foolish to waste first-class practical experience in moulding and melting by rule of thumb methods of buying and mixing raw material. Success in the foundry could be achieved only by the intimate co-operation of a number of people, for in no industry are the technical and the practical sides so closely interwoven and so dependent upon one another. It was easy to see that a foundry might, by producing excellent castings at non-competitive rates, find itself in commercial difficulties. It was also easy for a foundry to carry on for many years without serious difficulty by rule of thumb methods if there were excellent men on the foundry floor. Neither of the conditions was any argument against science in the foundry, but the application of science had to be justified, and invariably could be justified, in every respect on economic grounds. Scientific investigation and research was of vital importance to the industry, but other factors in its success could not be ignored: the human factor involved in the employment of labour, the economic factors relating to costing, prices and delivery.

The Engineer and Cast Iron.

In engineering practice in the past cast iron had invariably been the first material used and the earliest to be discarded in favour of something which had high specific properties, either generally or in particular directions. Cast iron had been a sort of metallurgical Cinderella, and had never had, or had never been, considered worthy of that consistent metallurgical study which had been put behind steel in Sheffield, or behind malleable iron in the United States. Cast iron was peculiarly subject to competition, not merely from other countries, as the result of cheaper labour, raw material and transport costs, but from other materials, always seeking to expand their applications at the expense of cast iron. In the past twenty years enormous advances had been made in certain industries, notably automobile, aeronautical, electrical, marine engineering, internal combustion engineering. All these industries employed cast iron in some form or another, and yet it was extremely doubtful whether the output of iron castings had sensibly increased. The whole of the increased output of pig-iron had gone into steel. The engineer replaced cast iron largely because it was neither sufficiently uniform nor sufficiently homogeneous for structural purposes. Its low specific properties, such as tensile strength, were also against it, but these could be taken into account by the designer, provided the material were sufficiently reliable. It was sometimes said that the engineering user would not pay for better cast iron, but the fact was that the engineer sees no purpose in paying for better irons in cases where cheap ones are good enough, or in paying for better irons unless the improved quality can be obtained consistently and regularly, so that designs can be permanently altered, and full advantage taken of the increase in strength.

A great stride forward in this direction had recently been taken in the establishment of a Main Committee on Cast Iron by the British Engineering Standards Association. The Institute of British Foundrymen had submitted a specification for general adoption which would enable engineers to depend upon getting specified properties regularly.

Furthermore, the industry required to secure what knowledge it could of the constitution, the properties and methods of manufacture of cast iron, so that it could be used as fully as its cheapness and inherent properties permit. Nobody wished to see cast iron used in cases where it was unsuitable, but there were many applications in which cast iron was not used, but where it could suitably replace other materials with a saving in cost.

Co-operative Research.

It had been proved repeatedly in connection with other industries that scientific investigation was the proper way of securing the necessary improvements. The number of men who could conduct research was small, and the amount of

* Summary of a series of addresses delivered to members of the Institute of British Foundrymen, Joint Meeting of the Sheffield and District and East Midlands Branches at Staveley, Sept. 27, 1924, Newcastle-on-Tyne Branch, Dec. 13, 1924, London Branch, Nov. 6, 1924, and Scottish Branch, Jan. 10, 1925, at Glasgow.

money the industry could at present devote to expenditure in research was limited. Furthermore, the majority of the problems concerning founders was common to all, and might, therefore, be solved for the whole industry. These considerations suggested the desirability of collective action in research work, and had been the guiding principles in the formation, in 1921, of the British Cast Iron Research Association, which has now been in operation just over three years. It is a national, Government-aided body, founded to give assistance to producers and users of pig, grey and malleable iron, and to conduct investigations on these materials.

The British Cast Iron Research Association.

Any British-controlled foundry or engineering works was eligible for full membership and to receive reports and results of investigations. Foundries differed considerably in type. The small jobbing foundry frequently had a varied output, and could not afford any form of technical control. Even if it had such control, the amount of work in any particular line scarcely justified special mixtures. The large engineering works frequently had its own foundry, engaged for the most part on specialised products for the works, such as automobile or engine cylinders, machine frames, bedplates, etc., but also having to carry out a proportion of general and jobbing work for works and general maintenance purposes. Finally, there was the specialised foundry, either large or small, which tried to concentrate entirely on one line, and which sought to obtain the economies of such concentration. The Association had to cater for all classes. The last two types of foundry frequently had proper metallurgical control, and were able to interpret the results of investigations without aid, and frequently dealt with their own technical problems. The small founder occasionally required advice in matters of difficulty and aid in the interpretation of research results, so that he might apply them without trouble, and the small founder was such an important part of the structure of the industry that he needed special attention. Apart from advice to members and the services of the Information Bureau and Library, which issued quarterly a Bulletin containing abstracts of foundry literature, and which was always at the service of members, the Association conducted a series of investigations both in its own laboratory and in other prominent laboratories throughout the country. Before mentioning the investigations in progress, it was desirable to refer to the work done in co-operation with the Institute of British Foundrymen in standardising a test-bar for cast iron and for establishing specifications, which were now being considered by the British Engineering Standards Association. Much of the work done by the Association depended upon information received from members, and in certain cases members had been invited to furnish information relating to their cupola and temperature-measuring practice, and practice relating to moulding sands and blackings, etc. The widest variations had been noted in cupola practice, and any member could obtain a detailed statement showing what his cupola should be capable of doing if it were being run on the most modern lines.

Researches in Progress.

The researches in progress were of two kinds. Some were of immediate practical importance, and yielded information of value at once to the founder; others attempted to probe into the constitution of cast iron, and to ascertain the reasons for its behaviour.

An important group of investigations was connected with improved cast irons, notably irons for resisting corrosion and heat, and irons for resisting abrasive wear. In certain cases the influence of special elements was being studied, and a definite attempt was being made to ascertain the precise influence on properties of producing a pearlitised iron, as distinct from irons cast under exactly the same conditions, but cooling at rates other than those calculated to give a pearlitic structure. An important investigation had been completed on automobile cylinders and pistons, and cylinders were now being made for service tests in conjunction with the British Motor and Allied Manufacturers' Research Association to mixtures recommended by the C.I.R.A.

Further important investigations were concerned with moulding sands and blackings, and other work in hand concerned the measurement of melting and pouring temperatures, studs and chaplets, and cast iron for electrical and magnetic purposes. Finally, an important investigation was in progress relating to the properties of grey iron, and to the influence of the various elements in cast iron on properties. Experimental work was also being conducted on malleable iron, and important developments in this direction were anticipated. In all cases the Association had access not only to laboratories, but to works plant, including cupolas, annealing furnaces, etc., where full-scale investigations could be carried out.

The Association also co-operated with independent workers in the country and elsewhere on cast iron, and particularly was associated with the work of the Ferrous Alloys Research Committee in the important fundamental investigations being conducted at the National Physical Laboratory.

The Cast Iron Research Association was national in character, and British founders during the next eighteen months would have the opportunity of determining whether it should develop on permanent lines for the benefit of the industry as a whole.

Discussion in London.

THE BRANCH-PRESIDENT (Mr. V. C. Faulkner), referring to the reason for the growth of the knowledge of the metallurgy of steel, and the paucity of the research done on cast iron, said that, generally speaking, for the quantity production of steel, a considerable amount of capital was necessary, whereas with cast iron any person, having but a few pounds, could probably start in business for himself. He had little or no overheads, and could work in competition with well-established foundries, with the result that founders could rarely show profits commensurate with their enterprise, unless they were engaged upon a speciality. Glancing through the list of members of the British Cast Iron Research Association, he was a little surprised that it included no railway companies or Government departments. He did not know whether there was anything in the Articles of Association which prevented Government departments joining. With regard to the questionnaire sent out by the Research Association in connection with cupola practice, he had noticed that the weights of materials charged were asked for, but he was of the opinion there were at least 10 per cent. of the foundries of Great Britain that could not give that figure, as they had no weighing machines. At a recent Council meeting of the Institute of British Foundrymen, the Officers and Branch-Presidents had been invited to become members of the Council of the Research Association, and had accepted. With regard to acid-resisting cast iron, the Branch-President asked whether the Research Association had investigated "Thermisild," the German product, which had certainly met with a good deal of success in Germany.

Type of Research Suggested.

Finally, he suggested that the Association might very usefully include amongst its researches the following:—They might take a number of brands of pig-iron and weigh out exactly 100 lbs. of each, and then melt them in crucibles of similar type, in order to get comparable results, and state the amount of slag given off by each particular type of pig-iron. He believed that some very surprising results would be forthcoming, because research was showing more and more every year that the difference in the properties of cast iron depended on the amount of fluidity, and that sudden lack of fluidity was due to slag or dirt inclusions.

B.C.I.R.A. and Profits.

MR. J. W. GARDOM said that the first thing that founders wanted to know was how to make a profit, and he wondered if the Association was going to help them in that way. The Association was helping, of course, in regard to the better

quality of the materials produced, but he considered that the main lines on which they should work, with a view to making a profit, was to improve costing systems. Apart from that, the Association would do the industry a great deal of good. It would be interesting to know if the Association was intending to give founders service after it had indicated to them the methods of working. It was all very well to say such and such an iron, but irons varied from day to day. With regard to membership, he asked if the Association proposed to give to new members the reports published in the past. He wanted to know because he was trying to increase the membership, and suggested that if that were done it would go a long way towards inducing people to join.

B.C.I.R.A. and Patents.

MR. H. J. MAYBREY, B.A., said that Mr. Pearce had indicated an interesting series of researches, but there was one point on which he was not clear. Supposing, for instance, that the Association succeeded in producing a corrosion-resisting cast iron—as he hoped it would—he gathered that it would be by some process which would be patentable. In that case, presumably the patents would be taken out and vested in somebody. Would the subscribers to the Association have the right to use the patents, or would they have to pay a fee to work the patents on licence? He imagined the latter would be the course pursued. He had asked the question because he had come across the same thing in the non-ferrous industry, especially with regard to corrosion. The Corrosion Committee had discovered a process for protecting aluminium by chemical methods, and he gathered that a patent had been taken out and vested in the Department of Scientific and Industrial Research, and that any worker who desired to use that patent had to do so under licence. He could not possibly see the use of being a member of the Research Association if any Tom, Dick or Harry, who had not had the pluck to subscribe could step in and reap the benefit of the work which was supported by members of the Association.

Associate Membership Benefits.

MR. G. C. PIERCE, after expressing his thanks for the lecture, said that recently his employers had handed him the prospectus of the Cast Iron Research Association, and had asked his opinion as to whether it was worth while joining. He had replied emphatically that it was certainly worth while. On the other hand, he could not see what advantage an individual would get by joining as an Associate Member, though he might be wrong in that respect. Were the quarterly Bulletins issued to Associate Members? Again the Bulletins contained abstract reports of investigations, but it was not possible for the Associate Member to obtain complete reports, apparently.

MR. R. J. SHAW asked if it was worth paying the subscription for the use of the library.

Research into Costing Systems.

MR. H. O. SLATER, as one of the oldest members of the Institute, felt particularly proud because the formation of the Institute and of the Research Association was the result of the efforts of a very small number of practical foundrymen who had seen the necessity for scientific research, and he doubted whether any of them realised the far-reaching effect of their early efforts. He felt that in some respects the Research Association had gone far beyond the real practical man, and had developed far more than some of them had anticipated, though the interest of the practical man was just as necessary to-day as in the past. The foundry industry had suffered from a lack of scientific research into the costing systems of foundries. He welcomed trained scientific men from the universities, but the industry must have the practical man as well, who had brought the industry to its present stage. Employers were realising more than ever that the moulder was not to blame because the industry was not in the state it should be in. It was his belief that the employers themselves were largely to blame, in view of their lack of interest in research in the past.

THE AUTHOR'S REPLY.

In reply to the Branch-President, MR. PEARCE agreed that the steel industry was better off than the iron industry, because it required more capital to run it, and was conducted on a bigger scale. It should be remembered, however, that the non-ferrous industries were taking up research with enthusiasm, and it certainly required less capital to start a brass foundry than an iron foundry. He noted with pleasure the increase in closeness of relations between the Research Association and the I.B.F.

With reference to Mr. Gardom's suggestion that profits to-day did not permit research to be done, the speaker said that it was arguable that properly conducted research permitted larger margins of profit than were generally obtained in competitive working, but normally during trade booms firms were too busy to do research, and when trade slackened there was no money for development. He protested against the attitude occasionally adopted by possible members, that they would join when the Association produced results. Such founders were trading on the courage and foresight of members who had already joined. The Association was quite willing to assist members in difficulties with regard to foundry matters.

In reply to Mr. Maybrey, Mr. Pearce said that members were entitled, by virtue of their membership, to work patents taken out by the Association. Foreigners were excluded from membership of the Association. Colonial members were admitted provided the companies concerned were British owned and British controlled. In France, Germany and America considerable interest was being taken in the work of the Association, and in America steps were being taken to carry out work on similar lines.

With reference to the question of the individual member versus the member firm, the individual member received the quarterly bulletin and the use of the Library for 30s. per annum. Clearly such members could not be given the full research reports. The constitution of the Association provided that ordinary members should be manufacturing firms producing cast iron. The minimum subscription was £5 5s. per annum for ordinary members, this being for a foundry employing not more than twenty-five men. The rate increased gradually up to a maximum of £250 per annum, which represented the subscription for approximately 2,400 men.

Discussion at Newcastle.

Practical Application of Results.

THE PRESIDENT (Mr. G. W. Frier), opening the discussion, remarked that Mr. Pearce's lecture had set him wondering as to what part the foundryman was going to play in all the improvements which were to take place, because they would certainly not be all done in the laboratory. When the scientific man had done his quota the foundryman would have to use his brains more than he was doing at present, and he would have to consider how the results were to be applied. The scientific man would be giving him all kinds of cast iron to use, and he would have to make moulds suitable for it. All this would mean much greater responsibilities on the part of the practical foundryman.

Advisability of Issuing Secret Reports.

MR. V. STOBIE said, speaking from the point of view of a member of the steel industry, that one could get information regarding almost any steel from about a dozen books or, failing that, from the people who made it, but the average cast iron foundryman could not give much information about his product. If the engineer could not get serious information about cast iron, what was he to do? He did not agree with some of the methods of the Association, and thought that, on this occasion, it might be permissible to criticise some of the ideas put forward by the lecturer.

Only subscribing firms received research reports. He (Mr. Stobie) did not think that that kind of procedure was followed in the case of the steel firms. If steel firms made a research and spent a large sum of money on it, they did not deny the engineer the information so gained. He thought that the secrecy of the cast iron people would prevent progress, and, consequently, this metal would

remain the metallurgical Cinderella. He thought that Mr. Pearce should try to persuade his Committee to eliminate secret reports.

Chemist Necessary to Utilise Information Received.

Mr. James Smith said Mr. Pearce had told them that for the benefit of the small ironfounder they were prepared to supply him with mixtures which would withstand certain tests, without having the aid of the chemist in the foundry, but he (the speaker) was of the opinion that it was still going to be rather a difficult matter. The Association might give a foundry a certain mixture for cast iron, without any analysis having been made, but how did they know exactly what the foundry was using, because every foundry had its scrap and different brands of pig-iron? They were all pretty well versed as to what one received from the average pig-iron maker, but no man knew what he was receiving from his scrap merchant. How was the B.C.I.R.A. going to overcome those difficulties? If they were to assist the small ironfounder and help him out of his difficulties, how did they propose doing it if he had not a chemist, because, after all, it was the analyses which were important.

Reception of Science by Foundrymen.

Mr. H. J. Young, F.I.C., said, speaking of the foundry trade as a whole, he pointed out that when one asked a brassfounder to make, say, 88: 10:2 gunmetal to pass the necessary tests, he would do so willingly. If, however, one went to an ironfounder and told him to make an iron to a certain specification, he generally said it could not be done. The average ironfounder could not make iron to any certain composition and test result, and, in many instances, he would not try to do so.

During the past years, the complaint had been made, in the Newcastle Branch, that the chemist talked over the head of the foundryman, but, the speaker believed, the truth was that the foundryman ducked his head. He had heard it said, relative to the Institute, that the less the chemists have to do with it, and the fewer scientific Papers, the better. On the other hand, the only hope for the future was in having more of these, no matter how unpalatable they might be.

Research work in cast iron must be done. The only point was whether it would be done by our own—the British—Research Association or by somebody else. Nobody could do it without adequate financial backing which meant, in this case, universal support.

It should not be necessary for Mr. Pearce to go round the country explaining the purpose of a National Association, but, at the same time, they were indebted to him for the information he had given them.

Mr. W. J. Paulin said he noticed that research work was generally on the lines that would benefit a large works. He thought it was a generally recognised fact that the chemist could not exist in every small foundry.

Irons were often referred to as "ordinary iron" or "good cylinder iron," etc., and those terms had been criticised as being very loose. They had lasted many years, however, and when the average foundryman said that one would get 50 years' service from a certain metal, he said it with confidence and was generally right.

He was interested to note that the lecturer had mentioned the carrying out of tests on motor cylinders and pistons, and thought it would be interesting to know the nature of those tests. He would also like to know if lubrication came into the question or if they simply worked with dry metals?

In spite of the doubt thrown upon scrap, everyone knew that it was a very useful material in the foundry, and the man who breaks it up generally can tell, from his experience, the nature of it, and, although he might not be able to tell the composition, he could get within certain limits. These limits were generally quite within the needs of some particular effect he wished to produce, but he could produce that effect with far greater certainty if he had the knowledge obtained by the B.C.I.R.A., as the result of their experiments. Having heard Mr. Pearce, he felt much more confident of the possibilities of the B.C.I.R.A. than he had ever done before.

Mr. Gallon said that he was a member of the B.C.I.R.A. and found it well worth the while. The owners of many small foundries had not had the opportunity to study chemistry, and they were feeling the need for it to-day. If a small foundry could not afford to keep a chemist, what was it to do? The only alternative seemed to be to join the British Cast Iron Research Association. If the Association did nothing else, it gave them confidence in the metals they were using because, by reading the reports of the Association, they found that certain of the mixtures were as near as possible to the ones they themselves were using. He thought that the annual subscription was well spent, because they had the co-operation of the best brains in the country, and also he thought that 30s. per annum for the individual member was extremely reasonable.

THE AUTHOR'S REPLY.

Mr. Pearce assured Mr. Stobie that everything would be done to acquaint engineering users with the possibilities of cast iron, and of any improvements which arose through the work of the Association, but it would scarcely be fair to circulate generally information obtained by the Association when it had been secured through the foresight of these firms which had the courage and initiative to join in the first instance. In fact, the Association could not make a practice of publishing its results generally under the Government scheme.

In reply to Mr. James Smith, Mr. Pearce said that a firm paying a subscription of five or ten guineas a year could scarcely expect the same services from the Association as a full-time chemist, costing, perhaps, with his overhead and materials charges a minimum of £500 per annum. The Association was prepared to do everything possible to help a foundry which could not afford to keep a chemist, but it could not infringe upon the work of the analytical chemist or consultant.

With reference to Mr. Young's comment on the statement that cast iron was the metallurgical Cinderella, Mr. Pearce hoped that he had not forgotten that Cinderella ended by living happily ever after after marrying Prince Charming, which in this particular case was the Cast Iron Research Association. He thanked Mr. Young for his kind remarks, and agreed that the object of these talks was to see that no people in the industry were unacquainted with the work that the Association was trying to do.

In reply to Mr. Paulin he would say that in the abrasion tests carried out by the Association the metal was quite dry, no lubricant being used.

Catalogues Received.

Engineering Instruments.—The Etablissements H. Morin, 11, rue Dulong, Paris (XVII) has sent us an eight-page catalogue which illustrates, describes and prices a number of drawing-office instruments and furniture. Drawing instruments, draughtsmen's mechanical drawing boards, theodolites, tacheometers, hardness testers, and many other instruments used by engineers are included.

Cupola Daubing.—Messrs. Thomas E. Gray & Company, Limited, have prepared a 10-page folder giving practical instructions as to how to line a cupola with "Silacene," a plastic refractory which they prepare and distribute. The diagrams are particularly clear, and no furnaceman should have the slightest difficulty in following the instructions given.

Melting and Pouring Appliances.—The S.A. des Etabs. P. H. Bonvillain et E. Ronceray, of Paris, have sent us a 12-page supplement for inclusion in their general catalogue. It describes and illustrates cupolas, both with and without receivers; the principle of the syphon tap-hole brick; tilting baby cupolas; fans; cupola chimneys; copper-melting furnaces; hot-air units; tilting crucible furnaces; white-metal furnaces; geared and ungeared ladles. These units are handled in Great Britain and the Colonies by the Universal System of Machine Moulding, Limited, 97, Queen Victoria Street, London, E.C.4.

Cast-Iron Pipes.—The monthly stock list for February issued by the Staveley Coal and Iron Company, Limited, of Chesterfield, is now available.

The Draughtsman and Foundrywork.

By M. WARNOCK.

In a recent issue of the Journal an article appeared bearing the title "Foundry Work and the Draughtsman," and outlining the views of a practical foundryman on this subject. The article expressed throughout the desire of closer co-operation between the drawing office, pattern shop, and foundry, and perhaps the views of a draughtsman will help toward this end.

The most important reason for the draughtsman's neglect of foundry work is in most cases due to the fact that he has very few channels through which he can gather the necessary knowledge. Many valuable text-books are issued on the subject, but, as every practical man knows, theory is not sufficient on which to base a design of a job suitable to foundry requirements. Contact with practical men, with the aid of text-books, is the only way to achieve the required end when it is not possible for the draughtsman to get a few years' experience in practical foundry work.

In many instances the draughtsman gains his engineering knowledge with a firm who have no foundry, and as his work is all within the four walls of his particular firm's buildings, he does not get the opportunity of visiting the foundry where his design is turned into cast-iron form. It is therefore evident that this type of designer has the chance of becoming an efficient engineer from the machine shop standpoint, but the important part of moulding is inevitably neglected.

There is one suggestion which would go far in helping the three trades connected with the production of castings to give products of a higher class and cause less inconvenience to all. The "Associations" of these three métiers (draughtsmen, patternmakers and moulders) could be allied with the object of understanding the peculiarities related to the respective arts. This closer working would bring the practical men in each trade into contact, when, by means of works visits and lectures, many hazy points could be cleared up. A group of draughtsmen, for example, visiting a foundry with an equal number of moulders would then get the opportunity of clearing up matters which would otherwise remain vague to them, and, of course, *vice versa* with a number of moulders visiting a factory where the castings pass through the various stages of machining. Evening classes suitably arranged to teach these branches in conjunction would be a good method of preventing the present negligence amongst the younger tradesmen especially.

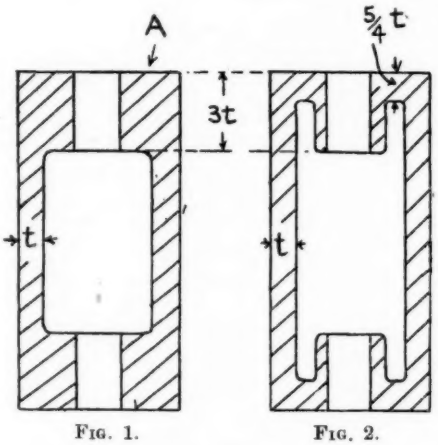


FIG. 1.

FIG. 2.

A year or two in foundry work would most certainly be a great help to the designer, but not sufficient to allow him at all times to design a pattern which would be perfect in the eyes of the moulder. The moulder with years of experience behind him is often cheated by the peculiar performance of certain jobs, and it is therefore obvious that a few years cannot give the required knowledge to overcome such difficulties. It is often the case that the moulder goes home full of cheer after what he thinks is a splendid cast, and returns in the morning to find that by some unseen means his hopes are shattered. Where possible, the drawing office, pattern shop and foundry must combine during the design of a job. If a draughtsman has the advantage of having a foundry at hand, then before he proceeds with the details of his design the foundryman should be called in to point the main features of the patterns that must be watched relative to his duties. Until the office man gets this idea well into his mind the perfect castings cannot be produced.

The foundry, however, can still go a long way towards giving the engineer a better finished casting. The design is not always to blame for faults which are at once obviously due to carelessness in the mould. The author has found moulders in many cases to be very careless in measuring parts of a mould. When a pattern indicates certain shapes and definte sizes of cores, then it is the duty of the moulder to endeavour as far as possible to keep to those sizes. It is quite a common thing to hear it said that a moulder's eighth is a quarter of an inch, and this should not be. Many examples could be put forward showing this carelessness, but it is a trouble for which the remedy is simple.

When the moulder produces castings in accordance with the following main points the engineer will have many difficulties removed:—(1) Castings of correct size and shape; (2) castings sound and clean; and (3) castings having the correct physical properties and to specification if necessary.

The foundry by uniting with the engineers have nothing to lose, but all to gain, just as is the case with the engineer. When a moulder understands the principles of machining and design he is more likely to produce a casting in compliance with the conditions he knows the casting must fulfil. Further, the engineer has the necessary mechanical knowledge to invent mechanism to aid the foundry in many laborious tasks. Mechanical appliances in the foundry are still in a state where improvement is necessary, and the only way to gain this advancement is a mutual understanding between the trades. Many skilled moulders have a grudge against machines in their shops, but they must realise that mechanical means is the method of producing with accuracy.

There are one or two points in Mr. Sutcliffe's article which could be remarked on from a draughtsman's viewpoint:—

(1) Draughtsmen do not look for castings correct to $\frac{1}{1000}$th part of an inch, otherwise a great deal of machinery would be eliminated, but they do expect to get castings suitable for the performance required of them and having an appearance creditable to the work spent on them.

(2) It is quite simple for the drawing office to alter some part of their design to suit the moulder, but this alteration is necessary at the outset of the job, not after the pattern has reached the foundry, obviously involving the co-operation of the foundry before the details are proceeded with.

(3) Unequal thickness cannot always be avoided, but the effects could in some fashion be reduced to a minimum.

(4) When chilling becomes necessary in any mould the foundry must be consulted, as this is a question which is beyond the scope of the draughtsman.

(5) The draughtsman who reduced the strap pulleys to $\frac{1}{4}$ in. in the rim could not have much ability as an engineer independent of his foundry knowledge. Every engineer knows only too well that when a small allowance is made for machining and the tool is cutting hard skin and sand a great deal of time and labour is lost.

(6) Mr. Sutcliffe mentioned a particular hollow cylinder (Fig. 4 in his article), and mentions that he would like to know the reason for design No. 2. Some time ago the author had just such a case come before him. The cylinder was machined on all faces, and the bearing was required to be a certain length at each end. A cylinder such as Fig. 1 was first tried, but it was found that the top face "A" was always dirty, although various types of risers and runners were tried. Fig. 1 is the same as Mr. Sutcliffe's type 1, which he thought was most suitable. The foundry foreman suggested altering the design as shown by Fig. 2, and it was found that the even thickness of metal and reduction of the mass on top gave a sound, clean casting.

Institute of British Foundrymen.

NEWCASTLE BRANCH.

Discussion on Mr. A. Logan's Paper, "The Structural Composition of Cast Iron."

Opening the discussion, the PRESIDENT (Mr. J. W. Frier) said although perhaps it was not one which the average foundryman could discuss very well, it certainly contained much which he could follow out in practice. They had learned that they could get some idea of their irons by watching their fractures. He remembered once discussing with a workman some scabs on a certain casting, and the man had declared that it would always be so whilst there was so much steel in the mixture. After what they had heard that night about the different constituents of cast iron, the men would probably be turning round and saying "You will never get a good casting with all those things in it." It was evident, however, that the foundryman would have to co-operate still more closely in the future with the metallurgist.

MR. C. GRESTY thanked the lecturer for his kind remarks about his Paper, and said he certainly thought it was a good thing for the Branch that one paper should add another chapter to a previous one. The lecturer had mentioned the very important factor of time in the absorption of carbon. He (the speaker) would like to know whether there was any difference between the carbon-content of an iron melted in a cupola in which the metal remained in the well and that of the same iron melted in a cupola possessing a receiver. In the latter case the metal did not remain in contact with the coke once it had got to the bottom of the furnace.

The whole point of structural composition appeared to him to be rather analogous to that of the human body, the speaker continued. For instance, if the bodies of two men could be analysed, the percentages of carbon, hydrogen and so on, would probably be very similar and yet one man might have a weak heart and the other a strong one. Therefore, it was the structural arrangement that counted, and the same thing applied to cast iron.

He was interested in the "synthetic graphite structures" and thought that the author's idea of using strips of paper to represent the 10 per cent. was a very good one.

Increase in Phosphorus due to Concentration.

The lecturer had given a figure for the specific gravity of graphite and he would like to ask if it referred to graphite which had been extracted from cast iron or to the ordinary flake graphite.

Also, the author had stated that the amount of phosphorus remained practically the same in the cupola, but the speaker pointed out that there was always an increase in it. If so much iron was put into the cupola and a certain amount of silicon, carbon and other things, were lost, then obviously the phosphorus must be increased. He would say, that in the average foundry, if 0.8 per cent. phosphorus was put into the cupola, one would get out nearer 0.9 per cent. than 0.8 per cent., which he thought was a point worth remembering.

He was pleased that Mr. Logan had referred to the "pearlitic" iron process, because so far as he (Mr. Gresty) was aware it was the only process which was patented.

Although one often talked of iron being "totally pearlitic," he did not think that, even by means of the microscope, it was possible to tell the difference between, say, 0.7 and 0.9 per cent. of combined carbon. Therefore, it was evident that the pearlitic iron people did not require to work to "laboratory" limits to be able to say that the iron was pearlitic under the microscope.

With regard to the inherent qualities of special irons, he said that he had recently been in conversation with someone who sold a great deal of a certain cylinder iron. When he had asked him what there was special about this iron, he was told that they simply made all the iron in a blast furnace and picked out the very close-grained pigs, putting them on one side as special cylinder iron, whilst the rest was sold as ordinary iron. In spite of the fact that the two irons were of practically identical composition, the special iron was sold for about £3 to £4 per ton more than the second grade.

Grouping and Strength.

MR. J. E. O. LITTLE, referring to the author's remark that the graphite was all absorbed when the iron came down through the cupola, asked if he did not think that some of the graphite could persist in the cupola. In other words, could the iron not pass through the cupola without the graphite being all absorbed?

He noticed that the figure given by the lecturer for the specific gravity of pearlite was 7.8, and he wondered how that figure was obtained. If a saturated carbon steel was used, showing an all-pearlitic structure, would this be the same as pearlite extracted from iron?

Also the lecturer had stated that pearlite consisted of seven parts of ferrite to one of cementite. Was that ratio always the same? Speaking of graphitic carbon, it seemed strange that grouping gave increased strength, whereas grouping of sulphur gave decreased strength.

Iron Oxide in Cast Iron.

MR. V. STOBIE, referring to the contentious question of iron oxide in cast iron, said that he had once made a quantity of synthetic cast iron in an electric furnace. On taking samples out of the furnace, he had found the iron to be in a useless form for any purpose, being more like pumice than anything else. After adding some aluminium, he removed all the holes in the iron, which became quite solid but very open-grained. On adding still more aluminium, the grain became closer until it reached a point where it was extremely close and, when the material was tested, it gave well over 20 tons tensile on test bars 2 in. × 1 in. rectangular section over a 3 ft. span, long face vertical.

He would like to have heard more about the effect of silicon upon the sulphur-content of cast iron. In melting *steel* under chemically reducing conditions, they found that they could greatly reduce the sulphur by the addition of silicon, which formed silicon sulphide and slagged out. There seemed to be a good deal of room for research work in that direction in cast iron.

With reference to the lecturer's remark about ferrite and cementite, it seemed strange that a cast iron containing plenty of carbon should have thick patches of free ferrite not connected with pearlitic structure.

MR. W. J. PAULIN said that the lecturer had mentioned the fact that phosphide eutectic was squeezed about as the iron solidified, and he wondered if he had ever tried to squeeze it out completely.

Speaking of manganese sulphide, which the lecturer had shown in some of his photomicrographs, he would like to know whether it was the cause of what were known as hard spots in machining.

THE AUTHOR'S REPLY.

Mr. Frier had mentioned the fracture of pig-iron. To go by fracture was not altogether a reliable guide, but generally speaking, in a normal pig-iron, the fracture followed the silicon content of the iron.

Mr. Gresty had asked the question as to whether there would be a difference between the carbon content of an iron made in a cupola with a well, and of that made in a cupola with a receiver. So far as he (the lecturer) could tell, there would only be a slight difference, as he did not think the amount of carbon was determined by the time the metal stood in the well, but upon the conditions prevailing when it was traversing the melting zone. With some irons, however, there might be an appreciable difference. He had once made some experiments upon the question by running the cupola with the tap-hole open and taking samples, and then taking further samples after the tap-hole had been closed and the metal

allowed to stand in the well. As far as he could remember, the carbon content of the metal taken with the tap-hole open, was generally slightly lower than of that which had stood in the well of the cupola.

Mr. Gresty had compared the structural composition of cast iron with the composition of the human body. The ultimate composition might be the same in the case of ten people, but it was the way in which the ultimate composition was put together which counted. Similarly, an iron having a certain graphite content might be weak, whilst another iron with the same graphite content by weight, might be strong. If one knew more about this question, one would know more about iron generally.

The specific gravity of graphite was generally given as 2.25, and they had actually obtained this figure from graphite extracted from cast iron. He believed that Smalley had quoted figures for the specific gravity of graphite in cast iron as low as 1.5 and as high as 3.5, but how these figures were obtained the speaker was unable to say.

They knew that the melting point of cast iron varied considerably, according to the carbon content, and, therefore, the freezing point varied also. In the case of an iron with a high freezing point, the graphite would be small, through not being able to "grow," as it was fighting against the pressure of solidification. It was probable, therefore, that the specific gravity of that graphite would be higher than that in an iron where the solidification range was very wide and where there was, say, 1 or 1½ per cent. of phosphorus present, which increased the fluidity of the iron, enabling the graphite to find more room to "grow."

Mr. Gresty was correct when he mentioned that the phosphorus content went up slightly in the cupola, but he himself had not observed so large an increase as mentioned.

In reply to Mr. Little's first question, he said that he was of the opinion that graphite could not persist in the cupola, because, when the iron was trickling down through the melting zone, every portion of an individual drop would be exposed to the blast, and any free carbon present would almost certainly be oxidised. Certain other experimental evidence was now available on this point.

The ratio of ferrite to cementite was not always the same, but varied slightly, according to the conditions under which the pearlite had been produced.

Mr. Little had mentioned graphite grouping giving strong iron whilst sulphur grouping or segregation gave weak iron. This was in accordance with what one would expect.

He thanked Mr. Stobie for his remarks about iron oxide. He did not know what the general consensus of opinion was, but many people thought that iron oxide could not be present: whilst others were of the opinion that iron oxide *could* be present. The ordinary metallurgist was consequently placed in rather a difficult position, and did not know which to believe. It would require much experimental work to prove one thing or the other, and he regretted that as he himself had not done any work on this subject, he was consequently unable to express any opinion on the matter. Mr. Stobie had provided them with some evidence, however, which seemed to point to the fact that iron oxide *could* exist in cast iron.

It was feasible that the addition of silicon should cause a decrease of sulphur content. There did seem to be some connection between high-silicon and low sulphur irons.

He agreed with Mr. Paulin that it was possible to squeeze the phosphide eutectic out of a piece of metal, and he quoted an experiment in which the late Dr. Stead had succeeded in doing this, and thereby was able to examine and determine its nature.

He hardly thought that it was the manganese sulphide which gave the trouble in machining. He would say that it was due more to the high phosphorus than to high sulphur. Phosphide eutectic was often found in high phosphorus irons in the form of little hard segregations, which would give trouble in machining.

MR. M. B. HERBST (Senior Vice-President) proposed a vote of thanks to the lecturer.

Discussion on Mr. Faulkner's Paper on "Some Notes on Refractory Materials." *

THE CHAIRMAN (DR. J. L. HAUGHTON), after thanking Mr. Faulkner for his lucid paper, said that, although the subject was not strictly a metallurgical one, the metallurgist, whether he be a manufacturer or a research worker, was almost always dependent upon refractory materials. Referring to special bricks, he asked Mr. Faulkner whether he had not found very great difficulty in getting them made to anything like reasonable shape. He had had some experience before the war in the construction of a large furnace that was to be used for non-ferrous work. The original idea was to melt scrap brass in this furnace, and to try to get rid of the zinc and the lead in the brass by boiling it off. Actually, as far as he knew, the furnace was never used for that purpose, because, shortly after it was built, the war broke out, and it was used for the manufacture of brass for fuses, etc.

DR. S. SMITH agreed that the subject was of extreme importance to metallurgists, because the vessels in which metallurgical operations were carried out depended for their efficiency and life upon suitable refractories, though often insufficient consideration was given to it. One question which the author had not touched upon was that the lives of furnaces, and especially electric furnaces, for high temperature operations, depended almost entirely upon continuity of working.

MR. EDWARDS asked whether anything other than the ordinary firebricks was used for ordinary wind furnaces for brass and aluminium crucible melting.

DR. GULLIVER, speaking of the effect of pressure on refractory materials, asked if Mr. Faulkner did not think that the effect was partly that of squeezing out that part of the material that had already been fused.

MR. FAULKNER, in reply to the discussion, agreed with the Chairman that if anyone demanded special shapes of bricks, he would never get as good material as in normal bricks, especially for large-sized bricks, because he had found that the brick manufacturers had a standard temperature and a standard time of burning, which was usually insufficiently high or long for bricks bigger than the ordinary 9 in. x 4½ in. bricks. It was a pity that the brick manufacturers could not supply metallurgists with something of more dimensional accuracy. He was pleased to learn that nobody had criticised any of the fundamental laws he had enunciated. He believed it was established that pressure did lower the melting point of bricks. For most bricks they could at least count on a lowering equal to 10 Seger cones. With regard to continuity of working, he had certainly missed that point, and he had yet to find a refractory which would act like india rubber. If there were constant heating and cooling in the furnace, undoubtedly spalling or cracking took place, but, in spite of that, a well-bricked furnace would stand for week-ends and go right down to black heat without much damage. The major portion of the damage appeared to be done between black heat and normal temperature, but risks could be reduced by having tightly-fitting doors.

With regard to coating the bricks with emery powder, that did not appear to him to be quite the ideal. He had indicated the type of plastic refractories that should be used. Very fine silica sand could be obtained near London, and a very good clay—almost a pure china clay—could be obtained from Stourbridge, and by mixing those, keeping as far as possible a high sand percentage, say, 80 per cent. sand and 20 per cent. clay, they would obtain a material of really high melting point, which would appear to be ideal for this purpose. But it did seem unfortunate that nature condemned plastic refractories to contract, whereas the silica bricks expanded. That was rather a nuisance, but, by a little ingenuity, and by putting it on twice, or, if necessary, three times, good results could be obtained. The practice in connection with permanent moulds emphasised the theory he had enunciated, i.e., that the "business" surface should be a high-class refractory, but the backing should be a material of higher conductivity capable of relatively cooling it. There they had a cast-iron backing, which was a very good conductor of heat, and that was coated twice with a thickness of 1/16th in. or 1/32nd in. of a refractory which was bonded with silicate of soda. Then they coated the permanent mould for each heat with a carbon—lampblack, or something of that character—and that would stand metal being put in as many as 400 times.

* See last week's issue.

The Conveyance of Material in the Foundry.*

(With Special Reference to the Production of Light Castings.)

By J. M. Primrose (Falkirk).

When one considers the amount of material handled in the average foundry daily, it is surprising to find that so little attention has been paid to the question of the conveyance of material. The wheelbarrow has been superseded in some foundries, but in others it is still the main or the only means of conveying all materials. The necessity for substituting some other system for the mechanical handling of materials is therefore important if foundrymen are to reach the efficiency demanded by the engineers and get to a point to please them. In a light castings foundry, melting 30 tons per day, the material handled is, in round figures, 255 tons, made up of 5 tons coke, 30 tons pig-iron and scrap, 10 tons new milled facing sand, 30 tons molten metal, about 10 tons gates and runners, 20 tons castings, and allowing 1 ton of sand per moulder, which is understated, say, 75 tons sand handled twice, the total stated is reached. Eliminate some of the time employed in handling part of this bulk, and a rise in the output of castings will soon be observed.

The work performed by the unskilled men in the shop (if there is such a person as an unskilled man) amounts to roughly 105 tons, comprising coke, pig-iron and scrap, milled sand, molten metal, gates, and castings, and it should not be difficult to invent some system which will at least reduce the non-productive labour.

Demands of Various Sections.

Commencing with the cupola, pig-iron and coke are mainly man-handled, first from the truck, then to barrows on to the platform and charged to the cupola. All the men work hard, and it is difficult to see therefore where this can be reduced. One method is to have a sufficient number of trucks to enable two men to fill them up in the morning and leave them free to charge the furnace, thus setting free during the casting period two men, who can be better employed at that busy time inside the shop. Another method is that of the self-charger worked by one operator with a magnet and drop-bottom boxes for the coke. But the idea which appeals most to the author for a foundry of the size mentioned is a mono-rail running round the yard and having carriages fitted with scales for weighing. For speed and utility this method will outstrip most other systems. The rail could be run over the wagons and be used for unloading. If scrap is used, it will enable the ironfounder to buy unbroken scrap, which can be broken in the yard, as it ought not to be difficult to design an elevated part of the system to allow of ball and monkey to be brought into operation and the scrap broken up more cheaply than at present. Each foundry, however, has its own particular problem, and therefore no two systems can be altogether alike, but this Paper will have served its purpose if it shows the necessity for introducing labour-saving devices.

Sand Handling.

To deal with milled sand is a one-man job, and the only thing possible is to remove hard work, so that a moulder unfit for heavy work owing to age or other cause can be employed, if all the weight is put on the runway. The employment of boys is not advocated, as blind-alley occupations are undesirable.

Transport Facilities.

At present molten metal is conveyed throughout the shops in bogies which take two and sometimes three men to pull. Here a mono-rail can ease the burden and enable one man to take the metal to any part with twice the speed, less danger, and no hard work. A boy of 14 has been known to convey a ladle containing 10 cwts. of metal a distance of 170 yards in less than two minutes. Gates, runners, and castings can be dealt with as one operation, and, of course, the first two go back to the foundry and the last to the dressing shop. Labourers are often seen staggering with barrows loaded up with gates if the barrow contained 3 cwts. A mono-rail truck would take a ton and cover the ground in a quarter of the time, whilst the man would be as fresh as when he started to push it. This also applies to castings, and no road barrow or truck can improve upon it, whether hand or mechanically propelled. The necessity can be summarised thus—reduce carrying, eliminate delay, remove all strenuous operations by substituting mechanical for manual labour.

Economies Effected.

The first economy is increased production. Ease and rapidity of handling material enables moulders to devote more time to actual production, as the system removes and places material where it is required with a minimum of labour, and allows the skilled man to expend his energy in the most economical way. The removal of moulding boxes to and from the shop floor to the yard is carried out so easily that it is not necessary to hamper moulders with boxes not required, owing to the lack of labour, while the ladles in use can be reduced from 30 to 50 per cent.

Cost of Installation.

With reference to labour costs, it is not the purpose of this Paper to give facts and figures regarding any particular shop. This item really belongs to the management, but if one man is eliminated at 40s. per week, that would allow of an installation costing £1,000, taking money at 5 per cent. and allowing 5 per cent. for depreciation per annum. It is therefore not difficult for anyone to work out a system to suit his own shop, and calculate roughly the cost of installation. A shop equipped with labour-saving devices for conveying materials can command the best class of labour—if moulders, they are able to earn a better wage with less fatigue because of facilities in the shop—and if labourers, better working conditions owing to the elimination of heavy lifts, enable them to work to the best advantage. The facility with which all waste material may be removed gives a cleaner shop and floors, thereby assisting foremen to reduce waste to a minimum.

Important Considerations.

In any mono-rail system it is imperative to avoid junctions and points. As far as possible, design the system in circles joined up by junctions in as few places as possible, without, of course, injuring the continuity. It is advisable not to run mono-rails over the centre of bays worked by travelling cranes, but where this must be done, a movable bridge should be used, so that the efficiency of the crane is unimpaired. Crank mono-rails should be run wherever possible over moulders' places to prevent heavy lifts and to enable casting to be done by overhead rail with the hand ladle. The system should be arranged in such a way that the rails are free when casting commences and kept for the metal trolleys only until the cupola is dropped.

Each shop has its own problems and hence must adopt its own system, but whether a single rail or H-beam mono-rail is used, one thing is certain —present-day methods in this country must disappear if British foundries are to keep abreast of other countries in the race for the world's trade, and the key industry of all engineering must not lag behind.

DISCUSSION.

MR. AFFLECK, Branch-President, in opening the discussion, referred in complimentary terms to the Paper read by Mr. Primrose. With regard to the subject of the Paper, he said, that in the foundries of a great many automobile manufacturers in America the system of the moving platform was being adopted. While in light-castings work the

* A Paper read at a meeting of the Scottish Branch of the Institute of British Foundrymen, held in Glasgow Mr. J. Affleck presiding.

mono-rail was very good, for a mixed class of work, he thought, the moving platform would be better. It seemed to him that there were some cores that the only safe way to carry was on a hand-barrow. One system he had seen at work was what was called in the States the "mule." That was an engine and chassis. The apparatus was about 6 or 8 ft. long. It could be attached to bogies, and took the place of a horse, but there was power and speed behind it. This "mule" was used for taking coke into the foundry, taking castings into the dressing shop, etc. One thing about overhead transport that struck him was that it was best to keep it away from the men working on the floor. It was a disturbing thing to those engaged in fine work. Mr. Primrose referred to the effect of good transport on labour, and he (Mr. Affleck) agreed with him. He believed that if they could eliminate donkey work they would improve the class of workmen employed in the foundries very materially.

MR. GARDINER said the handling of material in the foundry was the be all and end all of the management. Where wages could be eliminated the cost became cheaper and commodities could be sold cheaper. That meant more demand and more employment. Personally he was more in favour of a jib crane, because with it one could pick up anything from any point in the yard and deposit it at the place where it was wanted. He had had considerable experience, and he found that a jib crane worked very well.

MR. LAURIE said he had also come to the conclusion that he was very well served with a jib crane. When they had to work two or three different brands of iron, which were usually distributed over the yard, these had to be collected. Referring to his own works, he said that even if he had an expensive installation he did not see how he could work with fewer hands than he had. He therefore considered that he would not be justified in undertaking the expense. The case of light work, of course, was different.

MR. ARNOTT said he would like it if Mr. Primrose had said more about the magnetic lifter, because that seemed to him to be a very economical method of handling pig-iron. It was not simply the transport of material from the yard to the foundry that counted. In putting down a new foundry for one class of work, it was easy to lay out an ambitious system, but it was a different matter in a foundry already established.

MR. A. CAMPION, F.I.C., pointed out that Mr. Primrose had confined his remarks to appliances suitable for light castings only. That must be borne in mind. Certainly the system he had described did very well for that class of work. The mono-rail no doubt saved a great deal of time and labour. The easier they could make it for the men the better was the work turned out. It was a waste of skilled men's time to employ it in shifting barrows.

THE AUTHOR'S REPLY.

MR. PRIMROSE briefly replied to the various points raised in the course of the discussion. It was quite an easy matter, he said, if one had a mono-rail running round the yard, to take up material and convey it just as they wanted it. He was quite certain that the system he had mentioned for handling coke was absolutely ideal. There was one foundry, not far away, that was putting in the American system, and they would be able to keep their furnaces going with two men. If they carried out their plans successfully, he thought the mono-rail system would have been proved to be right. They could depend on it that the Americans were not spending money needlessly.

Fritz Medal.—The John Fritz gold medal has been awarded to John F. Stevens, New York, "for great achievements as a civil engineer, particularly in planning and organising for the construction of the Panama Canal: as a builder of railroads and as administrator of the Chinese Eastern railway." This medal, it will be remembered, was established in 1902 in honour of John Fritz, pioneer in the American iron and steel industry, and is awarded annually for notable scientific or industrial achievement.

Concrete Hardening.

The Value of Calcium Chloride.

There has now been developed a very valuable process in connection with the application of concrete, the use of a small amount of calcium chloride in the gauging water. This accelerates the rate of hardening to such an extent that under ordinary temperature conditions a concrete floor or road can be made ready for use in 24 hours instead of a week, whilst, still more important, concreting can be carried on as usual in cold and frosty weather. All that is necessary is to use 2 to 4 per cent. of solid calcium chloride calculated on the weight of the cement, so that the method is extremely simple, as well as being inexpensive. The success now being obtained with the process is the result of a large amount of research work that has been carried out in Great Britain and the United States, particularly by Profesor Duff A. Abrams, of the Lewis Institute, Chicago. Thus, in one Paper presented by him to the American Society of Testing Materials in 1924 the figures represented the compression tests of over 7,500 specimens of concrete. The action of very dilute calcium chloride solution in this way corresponds, as already indicated, to an increase in hardening speed of about six times that of water, so that concreting can now be carried on in even the coldest weather, almost at freezing-point, in a manner equal to that of summer conditions with the ordinary methods.

The ultimate strength and quality of the concrete is not detrimentally affected, and as a result of the extensive research work devoted to the subject the only doubt remaining is whether the calcium chloride will have any corrosive action on the reinforcements. On theoretical grounds this would seem to be impossible, and certainly no case of corrosion from this cause has yet been discovered, concrete test pieces six years old, for example, not showing any sign of such action. Calcium chloride is a neutral and stable substance available to-day as a powder in a very pure condition, free from magnesium chloride—a somewhat objectionable compound which might conceivably cause corrosion. But since even a concentrated boiling solution of reasonably pure calcium chloride has no action on the iron pans employed in the manufacture of the powder, except to a slight extent at the edges where the air and the liquor are in contact, and the reinforcement is buried in the concrete away from air and moisture, the amount of calcium chloride is only a trace, and the temperature never exceeds about 70 deg. F. (21 deg. C.), it is difficult to see how corrosion can be regarded as a practical objection.

Finally, it may be mentioned that in the United States over 18,000 tons of calcium chloride per annum is now being used for this process, and its use is extending rapidly.

Foundry Query.

Sampling Manganese Steel.

Could you, or through the medium of your Journal, supply information as to how a sample of toughened manganese steel, *i.e.*, that which has been quenched, may be obtained? The sample must be sufficiently fine to carry out a direct combustion in oxygen for the determination of carbon. —A. F. CARNET, 18, Kingswood Road, Gillingham.

[The sample is heated to a dull red and drilled with a high-speed drill, running at high speed with a small cut. It is not an ideal method, as there may be a slight loss in carbon. Perhaps some reader could give an improved method.—EDITOR.]

THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND will hold its annual show this year at Chester, from July 7 to 11. The total prize money is over £16,000. The foundry trades will, as usual, be strongly represented by the agricultural implement manufacturers.

A New Type of Crucible Melting Plant.

Our representative recently had the opportunity of inspecting at the Battersea works of Messrs. Morgan Crucible Company, Limited, a new type of crucible furnace for steel-making. It is shown in plan and section in Fig. I. As will be seen, it takes four 80-lb. graphite crucibles, and is driven by forced draught supplied by motor and fan. This is brought in beneath steel fire bars at about 5 in. water pressure, and by means of a combined 1.5-h.p. motor fan running at 2,000 r.p.m., 1,000 cub. ft. per min. is introduced. The air being under pressure, very little by way of a chimney is necessary. The furnace has ample room, a feature we like to see in any furnace other than an electrically heated one. It takes sufficient coke initially for the complete process, which avoids the cooling of the furnace for re-coking, and obviously makes for economy. There is no need to compare the full economy with the

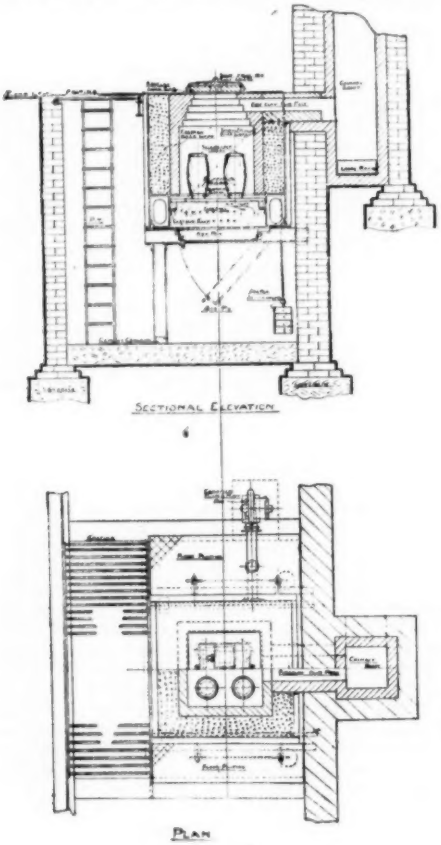


FIG 1

standard Sheffield furnace, as it is indisputably infinitely lower. The furnace, however, does demand graphite crucibles, which are more expensive, but they have at a minimum a double life. The use of graphite crucibles involves two metallurgical desiderata. Primarily, the steel picks up a certain amount of carbon, obviously varying with the time it is subjected to carburising conditions. Normally, the "pick-up" is about 0.15 per cent. Secondly, graphite crucibles are less pervious to gas, and consequently the sulphur absorption is less than with white crucibles. Here the time factor also is operating. Speed of melting, as would be expected, is increased. Graphite crucibles, unlike the clay ones, and owing to their ability to withstand sudden changes of temperature, are charged by hand before placing in the furnace. This allows of careful packing and the elimination of wedged scrap, which on expansion may crack any crucible.

Superficially it would seem, because of the carbon increase, that it would be impossible to make stainless steel or other steels demanding very low carbon content. However, designers of the furnace have developed a composite pot, the interior of which is of a carbon-free material, whereas the exterior is the normal mixture, and allows of those sharp changes of temperature rule on the ordinary "home-made" white crucibles.

Summarised, the plant shows advantages over the ordinary Sheffield type of pit-fired furnace in decreased fuel costs, lower sulphur absorption, ability easily to melt stainless and other low-carbon steels. As a plant suitable for the manufacture of steel castings on a small scale or as an experimental plant for the largest metallurgical concerns, the plant has much to commend it.

Tata Iron and Steel Company.

Capital Reduced.

The Tata Iron and Steel Company is now reducing its capital. For a long time past the directors have found that the present capitalisation of the Company is unwieldy. Out of a total capital of Rs. 10½ crores (£7,875,000 at 1s. 6d. the rupee) more than two-thirds are cumulative preference shares. On account of this, whenever the Directors have made proposals for providing the further capital required by the Company, the lenders have invariably insisted upon reorganisation of capital. As this large proportion of cumulative preference capital to ordinary share capital affects the credit of the Company seriously and impairs its borrowing power, it is now proposed to reduce the cumulative portion of the capital from Rs. 775 lakhs to Rs. 425 lakhs (£3,187,500). It is also proposed to extinguish the Company's liability in respect of overdue dividend on the second preference shares, by issuing profit-sharing certificates to the holders of shares of this class. Further, the special class of deferred shares will also be abolished.

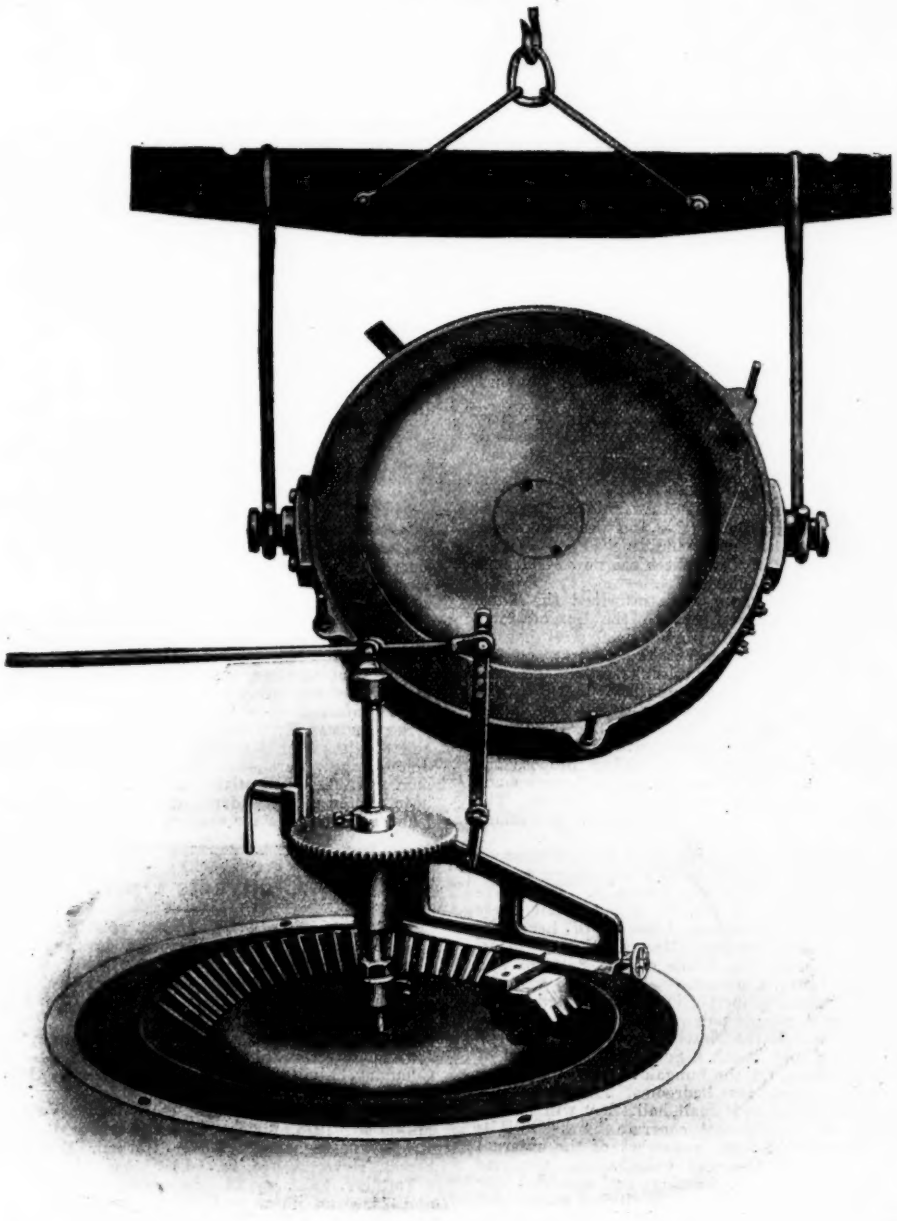
At the same time the Company has circularised its shareholders asking them to advance to the Company Rs. 10 (15s.) or more for each share held, and proposing that for the money advanced interest should be paid at 8 per cent. plus a share in the profit commencing from April 1 next in the proportion of 10 per cent. of the profit on Rs. 1 crore (£500,000) and less proportionately. Thus if a loan of one crore be raised, 10 per cent. of the profits would be payable to the certificate debenture holders in addition to 8 per cent. interest; if the loan is Rs. 90 lakhs, 9 per cent. of the profits would become payable; if Rs. 80 lakhs, 8 per cent., and so on; these profits to be ascertained after deducting Rs. 30 lakhs (£225,000) for depreciation. Profit-sharing certificate debentures will be issued for these loans, which will be redeemable by drawing lots after April 1, 1930, on six months' notice at par. The directors will give 2 per cent. discount to shareholders advancing the money, and they will also give 2 per cent. brokerage. The loan will be up to a maximum of one crore (£500,000), and if minimum of Rs. 50 lakhs (£250,000) is subscribed, no further shares, debentures or notes ranking in priority to or *pari passu* with these certificate debentures can be issued.

The circular explains that the Imperial Bank has advanced two crores (£1,000,000) as a cash credit at 6½ per cent., which is secured by goods, etc., in stock and in manufactures, and is guaranteed as to two crores by the agents and as to one crore by Sir Dorab and Mr. R. D. Tata. Second debentures for one crore have also been pledged to the Imperial Bank as an additional security.

The "greater extensions" are now completed, and the production of finished steel and pig-iron during the four months August to November, 1924, showed a marked increase over that for the corresponding period in 1923. The estimated gross profits for that period of four months in 1924 have been Rs. 33,92,000 (£254,400), that is to say, at the rate of Rs. 8,48,000 (£63,600) per month without including the additional bounties which will amount to about Rs. 4 lakhs (£30,000) a month. Against those profits the estimated charges (management expenses, interest, etc.) come to about five lakhs (£37,500) per month. Thus additional production and additional revenue are beginning to materialise, and the revenue will still further increase until full-capacity production is attained.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS, (MANCHESTER), LIMITED,

BLACKFRIARS, MANCHESTER.

Trade Talk.

BALDWINS, LIMITED, who are establishing an organisation in South Africa, have formed a subsidiary company, with headquarters in Johannesburg.

THE LAST CONSIGNMENT of 600 tons of steel work for the Paris Exhibition has now been forwarded from Sir William Arrol & Company's works at Swansea.

FULLER'S UNITED ELECTRIC WORKS, LIMITED, of Chadwell Heath, have cancelled the recent increase of 10 per cent. in the prices of all portable accumulators.

THE ARDEER FURNACES of Merry & Cuninghame, Limited, which were blown out at the end of last June, have been repaired and are ready for relighting.

THE NEWFOUNDLAND GOVERNMENT propose to utilise a portion of a loan they have raised in Great Britain by buying 10,000 tons of steel rails under agreement with the Trade Facilities Board.

AT THE MEETING of the Diesel Engine Users' Association, which was held on February 13, Mr. P. A. Holliday read a paper on "Submarine Engines and High-Speed Heavy-Oil Engine Electric Generating Sets."

MR. A. CAMPION, of 3, Strathview Gardens, Bearsden, Glasgow, has been appointed sole agent for Silacene, a plastic refractory prepared by Thomas E. Gray & Company, Limited, of 119, High Holborn, London, W.C.1.

A LICENCE under the Non-Ferrous Metal Industry Act, 1918, has been granted by the Board of Trade to the Baltic Export and Import Association, Limited, 174, Mansion House Chambers, 11, Queen Victoria Street, London, E.C.4.

THE STILL ENGINE COMPANY, LIMITED, have decided to concentrate the administrative and designing work of the company in the same building as its research laboratory, consequently the offices are now at Church Wharf, Chiswick, London, W.4.

G. & J. WEIR, LIMITED, have informed the Town Clerk of Glasgow, in respect to the Corporation's decision regarding the contract for 20 steel houses, that they are unable to accept the contract on the terms stated, namely, that building trade wages and conditions must be observed as laid down in the standing orders of the Corporation.

THE GLASGOW CORPORATION HOUSING COMMITTEE has agreed to recommend an experiment in the construction of a cast iron house. They propose the erection of two three-apartment bungalow houses made of cast iron at Langlands housing estate, Govan. The manufacturers of the houses are Walter McFarlane & Company, Saracen Foundry.

W. P. BUTTERFIELD, LIMITED, have now commenced the manufacture and supply of all kinds of presses and sheet metal working machinery generally. They have retained the services of Mr. F. Wood (until lately with J. Concord & Company, Limited, of Leeds) as manager of this department. Messrs. W. P. Butterfield have purchased the whole of the patterns and drawings of Messrs. Concord.

THE STEEL-FRAMED principle is being adopted in the construction of a sample pair of "Crane" type composite houses, which the Nottingham City Council is having built by John Booth & Sons, Bolton, as part of its housing scheme. Of the bungalow type, containing parlour, living room, two bedrooms, bathroom, lavatory, scullery, larder and small hall, they will have a frontage of 72 ft. Pre-cast concrete blocks will be used for filling-in the steel framework of the external and internal walls, the roof being tiled. Concrete floors with granolithic skimming are specified for the domestic offices, those of the living rooms and bedrooms being of composition. With the exception of the concrete raft upon which the houses are to be built, and the composition floors, the whole fabric will be delivered to the site in segments ready for erection.

THE COMMITTEE appointed to inquire into the present methods of generating and supplying electricity in this country and the manner in which such methods can be improved, has decided to recommend the standardisation of frequency, and the grouping or amalgamation of generating stations. The present varied practice in regard to the frequency of current is stated to be one of the primary difficulties which the committee found in the course of its investigations to stand in the way of a scheme of amalgamating electric power-stations which are thought to be far too numerous for efficient and cheap generation of electricity. It is understood that the committee has come to the conclusion, after considering suggestions, that an expenditure of about ten millions sterling will be needed to replace low-frequency by high-frequency plant and thus bring generating stations into line with each other. In regard to the grouping of electricity undertakings it is learned that opinions gathered from those concerned with private companies were generally favourable to the idea.

Company News.

Metal Propellers, Limited, 53, Parliament Street, London, S.W.1.—Capital £200,000 in £1 shares.

Midland Die-Casting Company, Limited, 71, Temple Row, Birmingham.—Capital £1,000 in £1 shares.

Castle Fuse and Engineering Company, Limited, 72, Haigh Street, Liverpool.—Capital £7,000 in £1 shares. Directors: C. W. Cox and C. E. C. Shawfield.

Auto-Mower Engineering Company, Limited, Morton Street, Philip, near Bath.—Capital £10,000 in £1 shares. Directors: R. Membery, G. Grist and J. Bourne.

Graham Enock Manufacturing Company, Limited, Margaret Street Works, Windus Road, Stamford Hill, N.16.—Capital £10,000 in £1 shares. Ironfounders, engineers, etc.

Aire Place Motor and Engineering Company, Limited, Aire Place, 143, Kirkstall Road, Leeds.—Capital £500 in £1 shares. Directors: J. H. Foster, W. H. Foster and C. L. Foster.

A. Petrook, Limited, 135, Hackney Road, London, E.2.—Capital £2,000 in £1 shares (1,000 10 per cent. cumulative preference and 1,000 ordinary). Brassfounders. Directors: A. Petrook and S. Ranwell.

Robert Morris, Limited, Atlas Works, King Street, Farnworth, Lancs.—Capital £16,000 in £1 shares. Ironfounders, mechanical engineers, etc. Directors: C. H. Taylor, H. B. Highfield, J. Morris and N. Pickvance.

Personal.

MR. R. MAIN, who recently retired from the offices of chairman and managing director of Merry & Cuninghame, Limited, has agreed to remain on the board of directors. Mr. H. S. Dunn has been elected chairman and managing director of the company.

SIR ERNEST WILLOUGHBY PETTER, managing director of Vickers-Petter, Limited, Ipswich, and chairman of Petters, Limited, Yeovil, has just been made the recipient of an illuminated address from the Ipswich employés of the firm, in commemoration of the knighthood conferred upon him.

SIR THOMAS H. HOLLAND has been elected president, and the Rt. Hon. Viscount Cowdray of Cowdray, Sir John Cargill, Bart., Mr. A. C. Adams, Mr. A. Duckham, Mr. A. W. Eastlake, and Mr. R. Redwood have been elected vice-presidents of the Institution of Petroleum Technologists for the ensuing year.

Contracts Open.

Melbourne, April 1.—15-ton electric travelling Goliath crane, for the Victorian Railway Commissioners, Melbourne.

Stoke-on-Trent, March 4.—Stores, for twelve months commencing April 1, 1925. The Chief Gas Engineer, Gasworks, Etruria, Stoke-on-Trent.

Aberdare.—Materials, for six months from April 1 for the directors of the Powell Duffryn Steam Coal Company, Limited. The Stores Manager, Aberaman Offices, Aberdare.

Dover, March 4.—Stores, etc., during year ending March 31, 1926, for the Dover Harbour Board. Mr. R. Mowll, register of Dover Harbour Board, Castle Street, Dover. (Fee, 2s. 6d.)

Torquay, February 28.—Supply and erection of steel and cast-iron pipes and valves in accordance with specification P.20, steam, feed, exhaust, drain and other piping, for the Electricity Committee. Mr. H. F. G. Woods, Electricity Offices, Upton Valley, Torquay. (Fee, £2 2s., returnable.)

Wolverley, Kidderminster, March 9.—About 150 tons of 4-in. and 125 tons of 3-in. spigot and socket cast-iron water pipes, with about three tons of ordinary bends and branches for same, for the Kidderminster R.D.C. Messrs. Fiddian, Barratt & Deeley, 13, Church Street, Stourbridge. (Fee, £2 2s., returnable.)

A European Magnesite Cartel.—A report from Prague states that all the European magnesite works have formed a Cartel for the production and sale of magnesite. The leading spirit is the Veitsch Magnesite Company, of Vienna; other works included in the Cartel are the Magnesite Company of Pressburg, the Radenstein concern owned by an American group, the Styrian Magnesite Works at Eichberg and Aue, the Weissenberg Works at Breslau, the Stella Works in Ratibor and Beuthen, the Eglinton Magnesite Brick Company, Limited, of Glasgow and London, and the West Bohemian Kaolin and Firebrick Company in Prague. The works included in the Cartel control 99 per cent. of the European output.

Sterling

This is our Style "S G" Box. An Ideal Box for Machine Moulding. Light, Strong, Rigid, Accurate. We have many other styles. Let us have your next enquiry.

What about ***your*** Foundry?

Are you getting maximum production per man-power-hour?

Are you getting accurate castings requiring only a modicum of fettling and finishing?

Have you got your scrap and reject account down to its irreducible minimum?

Finally, are you peacefully satisfied with the results of your Foundry?

Then why not give your foundrymen a better chance?

Give them STERLING ROLLED STEEL MOULDING BOXES to use and this chance becomes a certainty.

STERLING FOUNDRY SPECIALTIES LTD.
BEDFORD

LONDON OFFICE: 13, VICTORIA STREET, S.W.1

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Business in the Cleveland iron market remains quiet and uneventful, the demand for home consumption continuing on the recent limited scale, with few signs of an early revival of activity, either in buying or in furnace production. Purchasing at the moment is, in fact, almost entirely confined to relatively retail quantities, while on export account the recent weakening of French exchange rates has had a depressing effect in decreasing shipments to the Continent. There have, however, been some further negotiations with American buyers for the sale of a substantial parcel of No. 3 G.M.B., but so far no actual business has resulted. Considering the difficulties of the present position, values are well held, No. 3 G.M.B. being still quoted at 79s. per ton, with No. 1 quality at 84s., No. 4 foundry 78s., and No. 4 forge 77s. per ton.

The Tees-side hematite market is also correspondingly quiet, with the price of East Coast mixed numbers unchanged at 85s. per ton. On the West Coast similar conditions are experienced, Bessemer mixed numbers being quoted at 95s. per ton c.i.f. Welsh ports, 98s. 6d. per ton delivered at Glasgow, 102s. 6d. per ton delivered at Sheffield, and 105s. per ton delivered at Birmingham.

LANCASHIRE.—No change for the better can be recorded as regards local business in foundry iron, the ironfounders of the district being still in very keen competition with one another for any orders for castings on the market, and, of course, with the result that they seize every opportunity of beating down sellers of foundry iron. The Derbyshire ironmasters are, however, endeavouring to prevent No. 3 pig-iron from falling below 81s. at the furnaces, but one hears of sales in Manchester which could not mean more than 80s. 6d., and the appearance of the market suggests that 80s. on trucks is not unknown for this quality iron.

THE MIDLANDS.—Buying of foundry iron in this district is still confined within hand-to-mouth limits as the rule, with prices inclined to a weaker tendency as follow:—Derbyshire No. 3 foundry, 80s. to 82s. 6d.; Staffordshire No. 3 foundry, 81s. to 82s 6d.; Northants. No. 3 foundry, 74s. to 75s.

SCOTLAND.—Notwithstanding the recent drastic reduction in the output of foundry pig in the district, the nominal price of No. 3 foundry is now easier at 89s. at furnaces. The lower price is due to the paucity of business and the consequent cutting on the part of merchants to get rid of stocks.

Finished Iron.

Demand for all classes of finished material remains unsatisfactory, on the whole, even the works producing marked bars being but indifferently supplied with specifications beyond the next few weeks. In South Staffordshire orders for crown and nut and bolt bars are very difficult to obtain. What few lines there are coming through lack tonnage, and none of the works are running regularly. The makers say that they cannot produce the bars at less than the existing figure of £12 10s. for crown and £11 15s. for bolt bars, and it is difficult to see how things can improve whilst this competition obtains, especially as the foreign mills are not very busy in this department. There are plenty of Continental offers coming through for No. 3 iron at £7 15s. to £8 per ton for delivery in six to eight weeks, but even at this figure there is very little business moving, as the Darlaston trade is very quiet and much below the normal.

Steel.

At Sheffield the finishing branches of the industry have experienced some little improvement, and imposing quantities of railway and motor steel are being turned out. The home demand for the costliest makes of steel is exceeded by that from abroad. There is a good business in tools, and the demand in agricultural implements evidences signs of revival. There is, however, a lot of Continental semi-steel still coming into the market under old contracts, and until these are nearer completion business is likely to remain quiet. In the tinplate market the minimum price is being accepted for practically every line booked, and current quotations for the standard sizes may be called:—Coke tins: IC, 14 x 20, 112 sheets, 108 lbs., 23s. to 23s. 1½d. per box; IC, 28 x 20, 56 sheets, 108 lbs., 23s. 6d. to 23s. 7½d. per box, all net cash, f.o.b. Bristol Channel ports.

Scrap.

No improvement can be reported in the condition of the scrap metal trade, and in Lancashire, unfortunately, there is more cast scrap on the market than is needed for the amount of work at the foundries. Apparently it is easy to buy good quality parcels at about 80s. delivered, although some dealers still hold out for 85s., and one hears occasionally of 87s. 6d. for special lots of broken textile machinery. This particular class of cast scrap is not so plentiful as it used to be, when the cotton mills were buying new machinery more freely. In Scotland demand for scrap metal continues idle, with ordinary cast-iron scrap in handy pieces quoted 80s. to 82s. 6d. per ton, but buying is very restricted. Light cast-iron scrap and firebars are still around 75s. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Movements in the standard market have disclosed few features of special significance, fluctuations, however, slightly favouring buyers towards the close of the past week. It is recognised that the comparative stability of the price is due more to the fact that producers have a hold on the market than to any lessening of the interest of the speculative element. Recent happenings seem to confirm the opinion that there is little second-hand metal for disposal, and, where there is any, holders appear inclined to take their profit as early as possible. Current quotations:—*Cash*: Thursday, £64 7s. 6d.; Friday, £64 17s. 6d.; Monday, £64 15s.; Tuesday, £65; Wednesday, £65.

Three Months: Thursday, £65 7s. 6d.; Friday, £65 15s.; Monday, £65 15s.; Tuesday, £65 17s. 6d.; Wednesday, £65 17s. 6d.

Tin.—Values of this metal, on the whole, have been fairly well maintained in the absence of the free selling recently prevalent in the market, with more confidence apparent in the inherent strength of the statistical position. Consumption is proceeding very satisfactorily, and has more than absorbed the supplies of the month. The general tone of the market is looked upon as much healthier, owing to the very considerable amount of liquidation that has taken place, particularly during the last fortnight. Current quotations:—*Cash*: Thursday, £262 10s.; Friday, £263 10s.; Monday, £262 5s.; Tuesday, £262 7s. 6d.; Wednesday, £262 7s. 6d.

Three Months: Thursday, £265 10s.; Friday, £266; Monday, £265 5s.; Tuesday, £265 5s.; Wednesday, £265 7s. 6d.

Spelter.—The market for this metal has been subject to some slight fluctuations, and the outlook is regarded as favourable to an early expansion of demand. Statistics issued by Rudolf Wolff & Company give the world's output for 1924 as 992,324 tons, against 960,168 tons in 1923. The Belgian output amounted to 173,669 tons, against 141,549 tons, an increase of 32,120 tons. Current quotations:—*Ordinary*: Thursday, £36 15s.; Friday, £37 1s. 3d.; Monday, £37 1s. 3d.; Tuesday, £37 1s. 3d.; Wednesday, £37 2s. 6d.

Lead.—The market for soft foreign pig has recovered from the worst of the recent depression, and may go ahead again. Bears who sold at the lowest have been anxious to cover, and there is no doubt that the statistical position is quite sound. Current quotations:—*Soft foreign (prompt)*:—Thursday, £38; Friday, £38 12s. 6d.; Monday, £38; Tuesday, £38 1s. 3d.; Wednesday, £38 5s.

Iron and Steel Production in January.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in January amounted to 569,400 tons, compared with 580,300 tons in December, 636,600 tons in January, 1924, and a monthly average of 855,000 in 1913. The number of furnaces in blast at the end of January showed a net increase of five since the beginning of the month. The production included 188,100 tons of hematite, 161,800 tons of basic, 156,900 tons of foundry, and 30,800 tons of forge pig-iron. The January output of steel ingots and castings amounted to 605,100 tons, compared with 551,000 tons in December, 694,300 tons in January, 1924, and a monthly average of 638,600 tons in 1913.